USDA United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with New Jersey Agricultural Experiment Station, Cook College, Rutgers, The State University; and the New Jersey Department of Agriculture, State Soil Conservation Committee

Soil Survey of Union County, New Jersey

How To Use This Soil Survey

General Soil Map

The general soil map, which is a color map, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

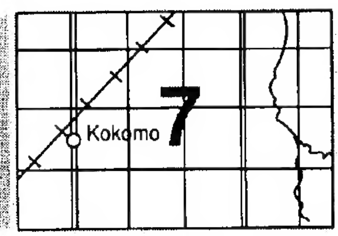
Detailed Soil Maps

The detailed soil maps can be useful in planning the use and management of small areas.

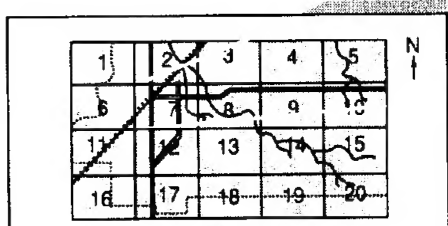
To find information about your area of interest, locate that area on the **Index to Map Sheets**. Note the number of the map sheet and turn to that sheet.

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Contents**, which lists the map units by symbol and name and shows the page where each map unit is described.

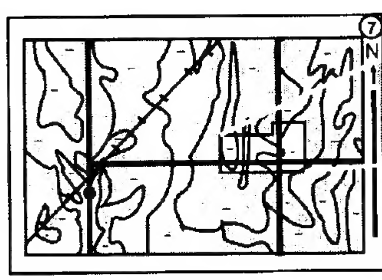
The **Contents** shows which table has data on a specific land use for each detailed soil map unit. Also see the **Contents** for sections of this publication that may address your specific needs.



MAP SHEET



INDEX TO MAP SHEETS



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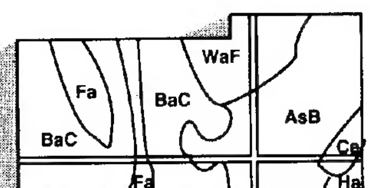

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (formerly the Soil Conservation Service) has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1980. Soil names and descriptions were approved in 1989. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1981. This survey was made cooperatively by the Natural Resources Conservation Service; New Jersey Agricultural Experiment Station, Cook College, Rutgers, The State University; and the New Jersey Department of Agriculture. The survey is part of the technical assistance furnished to the Somerset-Union Soil Conservation District.

Cover: Mapping unit of Boonton-Urban land-Haledon complex, 3 to 8 percent slopes, in the downtown park area of Westfield, New Jersey.

Additional information about the Nation's natural resources is available on the Natural Resources Conservation Service home page on the World Wide Web. The address is http://www.nrcs.usda.gov (click on "Technical Resources").

Contents

Issued 2002

Foreword

This soil survey contains information that affects land use planning in this survey area. It contains predictions of soil behavior for selected land uses. The survey also highlights soil limitations, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. The information in this report is intended to identify soil properties that are used in making various land use or land treatment decisions. Statements made in this report are intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service or the Cooperative Extension Service.

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State Conservationist
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Soil Survey of
Union County, New Jersey

By Dana Young, Thornton Hole, and Maxine J. Levin, Natural Resources Conservation Service

Fieldwork by Dana Young, Natural Resources Conservation Service

United States Department of Agriculture, Natural Resources Conservation Service
in cooperation with
New Jersey Agricultural Experiment Station, Cook College, Rutgers, The State University; and New Jersey Department of Agriculture, State Soil Conservation Committee

UNION COUNTY is in the northeastern part of New Jersey (fig.1). The county is bounded by Hudson County and Raritan Bay on the east, the Passaic River and Essex and Morris Counties on the north, Somerset County on the west, and Middlesex County on the south. The total land area of the county is 67,500 acres. The elevation ranges from sea level along the coast to 553 feet above sea level on the Second Watchung Mountain in Berkeley Heights.

This soil survey is an update to a survey of Union County published by Rutgers University in 1952. This survey provides additional interpretive information and maps that show the soils in greater detail.

General Nature of the County

This section provides information on the climate of the county and describes the physiography, relief, and drainage of the area.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Plainfield in the period 1951 to 1978. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is 32 degrees F and the average daily minimum temperature is 24 degrees. The lowest temperature on record, which occurred at Plainfield on January 22, 1961, is -7 degrees. In summer, the average temperature is 73 degrees and the average daily maximum temperature is 84 degrees. The highest recorded temperature, which occurred at Plainfield on September 2, 1953, is 105 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is 48.75 inches. Of this, 26 inches, or 53 percent, usually falls in April through September. The growing season for most plants falls within this period. In 2 years out of 10, the rainfall in April through September is less than 20 inches. The heaviest 1-day rainfall during the period of record was 7.09 inches on August 2, 1973. Thunderstorms occur about 25 days each year, and most occur in summer.

The average seasonal snowfall is 31 inches. The greatest snow depth at any one time during the period of record was 24 inches. On the average, 19 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in mid-afternoon is

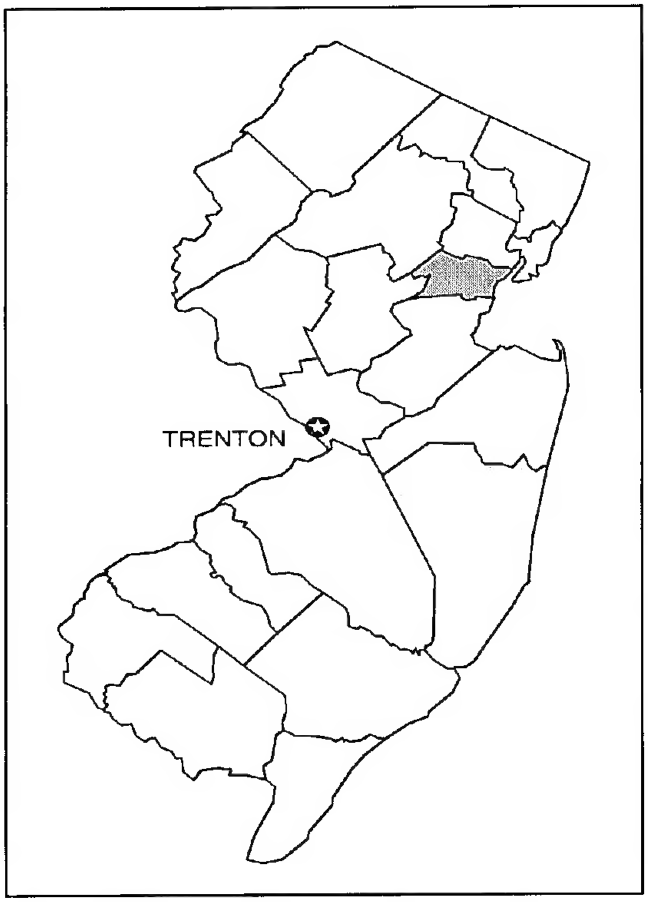

Figure 1.—Location of Union County in New Jersey.

about 50 percent. Humidity is higher at night, and the average at dawn is about 75 percent. The sun shines 60 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the southwest. Average wind speed is highest, 12 miles per hour, in spring.

Physiography and Relief

Reviewed by Max Olynyk, New Jersey state geologist, Natural Resources Conservation Service.

Union County is entirely in the Piedmont physiographic province of northern New Jersey. The Piedmont province covers almost one-fifth of the total area of New Jersey. It extends southwest from the Hudson River to the state of Virginia and is between the Highlands physiographic province and Coastal Plain province.

Although the Piedmont includes low mountains, ridges, and hills, the province is primarily a lowland with smooth, rounded hills separated by wide valleys. It slopes gently toward the Coastal Plain with no clear topographic distinction between these two provinces *(5)*.

The surface relief of Union County can be divided into two general areas, based on how they resist erosion.

One of these areas is the Watchung Mountains. They run parallel to the northwestern boundary of the county and consist of three closely spaced basaltic ridges. The ridges extend from Passaic County to Somerset County and include the western half of Union County. The hard basalt rock of the Watchung Mountains was formed by rapid cooling of extruded lava during the Triassic Period. Basalt is more resistant to erosion than the older sandstone and shale deposits that make up most of deep subsurface bedrock of the county*(12)*. As a result, the highest elevation in the county of 553 feet is on Second Watchung Mountain in Berkeley Heights *(4)*.

The other major topographic area is a gently rolling plain formed by the glacial moraine of a late-Wisconsinan ice sheet. Elevation of the plain ranges from 150 feet at the eastern side of the Watchungs to sea level on the eastern boundary of the county at the Arthur Kill and Newark Bay *(4)*. The broad, low, irregular ridge consists of undifferentiated rock debris called glacial till that was deposited at the margin of the ice sheet. The moraine crosses the eastern half of the county in a roughly north-south direction from Summit to Plainfield.

In addition to the Watchung Mountains and the gently sloping plain, are small areas of tidal marsh bordering the Arthur Kill and Newark Bay. These flat, wet areas are at sea level and are subject to tidal flooding.

Under most of Union County lies two major geologic formations: the Brunswick Formation of shale and sandstone and the volcanic basalt flows of the Watchung Mountains. Both formed during the Triassic Period of the late Mesozoic Era about 225 million years ago.

The Brunswick Formation, underlying the major portion of the county, consists of interbedded soft red shale and sandstone. Named for its prominent outcrop along the Raritan River at New Brunswick, its thickness reaches 6,000 to 8,000 feet between the Palisade Mountains in New York and the Watchungs in New Jersey and between the Watchung ridges.

The Brunswick Formation in Union County is generally too deep to influence soils, except where streams have cut deeply into the landscape. In a few areas the sandstone and shale beds are covered only by shallow layers of glacial till. However, in most areas the Brunswick formation has a thick cover of glacial till.

In the northwestern section of the county, there are three parallel ridges of hard basalt rock called the Watchungs. These ridges formed during a period of

volcanic activity in the Triassic Period. Each of these basalt ridges formed during a separate lava flow event. During these sequences, the lava poured out through vents along the northwestern side of the Triassic Basin. The lava quickly spread over an area of more than 500 square miles, reaching a thickness of 800 feet. The three Watchung ridges represent the thickest deposits.

Most of the Brunswick Formation in Union County is covered by glacial till from a late-Wisconsinan ice sheet. The till consists of loose soil and rock fragments scoured by the ice sheet; thus, the glacial deposits typically reflect the same red shales and sandstones as the Brunswick Formation. The deposits are several hundred feet thick in places. The terminal moraine, or debris deposited by the ice sheet's edge, crosses the county in a generally north-south direction from Short Hills to the Plainfield Country Club area.

A glacial outwash plain covers most of the Plainfield area. An outwash plain forms in front of the ice sheet, where sand, silt, gravel, and cobbles are deposited by meltwater in well defined layers or beds. Ground moraine consists of the glacial till that forms beneath the ice sheet, and consists of a variety of unsorted silts, gravels, cobbles, and boulders. The surface of ground moraine is undulating and is throughout the glaciated portions of the county in a thickness of as much as 90 feet.

In the vicinity of Galloping Hill Park is a long, narrow ridge of clean sand and gravel, called an esker. It was formed and shaped by streams of meltwater flowing in tunnels beneath or within the lower part of the ice. A related feature called a kame is in the Kenilworth-Galloping Hill area. Kames are hills of glacial meltwater sediments deposited in depressions in the ice or along its margins. The kames and eskers have high percentages of gneiss, quartz, and sandstone particles with a thickness of 20 to 100 feet.

In addition to changing the character and composition of the surface material, the glacial deposits also altered the drainage patterns. Most of today's natural lakes in New Jersey were formed by glacial action. None are south of the terminal moraine.

An unusual topographic feature that formed during the Wisconsinan glaciation was glacial Lake Passaic. It was the largest glacial lake in what is now New Jersey and was situated in the upper Passaic Valley between the highlands of Morris County and the Watchung Mountains.

Before the ice sheet's advance, the Passaic and Rockaway Rivers flowed through a gap in the Watchungs at Short Hills, while the Pompton and Pequannock Rivers flowed through a similar gap at Little Falls. When the ice sheet advanced across these areas, the natural drainage was blocked. What is now a tiny stream named Moggy Brook (a tributary of the North Branch of the Raritan River), was then a major meltwater river draining into glacial Lake Passaic. As the ice sheet withdrew, meltwater increased the dimensions of glacial Lake Passaic to an estimated 30 miles long by 10 miles wide and a probable depth of 160 to 200 feet over what is now the Great Swamp. As the margin of the glacier retreated northward, the Short Hills gap area was uncovered, but deposits of glacial till and outwash prevented it from draining. Eventually, the ice front uncovered the Patterson gap, allowing the lake to drain and leaving 80-foot thick clay deposits and the remnants of a wave-cut shoreline as evidence of its former existence.

A similar geologic-topographic feature created by altered drainage patterns was glacial Lake Hackensack. Remnants of the lake form the meadowlands bordering Newark Bay and the Arthur Kill, east of Elizabeth. This lake was once nearly 15 miles long and 4 miles wide. The former lake bed is now filled with silt, compressible and stratified sand, muck, and organic matter with an estimated thickness of 5 to 200 feet *(4)*.

Drainage

Reviewed by Eugene Koo, hydraulic engineer, Union County Division of Engineering.

Union County is east of the New Jersey drainage divide, which separates waters flowing east toward the Atlantic Ocean or west toward the Delaware River. Union County's surface drainage system follows a dendritic, or branching, pattern. This pattern is caused by the uniform hardness and permeability in the underlying bedrock. Water drains through the rock evenly, which encourages excess runoff to flow in small interconnected streams rather than following faults, soft spots, or cracks.

Two major streams, located in the northwestern section of the county, follow a course that is parallel to the Watchung Mountains. These streams, the Passaic River and Blue Brook, are known as subsequent streams. They flow at right angles into streams that follow the general slope of the Watchung Mountains. The streams closely follow the zone of relatively weak shale, between and beside the less yielding basalt Watchung ridges. The other two major county streams, the Rahway and Elizabeth Rivers, have cut channels across the downward sloping Piedmont geologic province, from the base of the Watchungs to Newark Bay and the Arthur Kill. These two rivers are called consequent streams because their stream courses are influenced by the initial slope of the land surface.

The land area of Union County is in six watershed areas or drainage basins. The Passaic, Rahway, Raritan, and Elizabeth watersheds are drained by extensive river systems, while the Morse's Creek and Bound Creek basins drain limited areas next to the Arthur Kill and Newark Bay.

The northwestern part of the county, the Upper Passaic Basin, is drained by a major tributary of the Passaic River. The headwaters of this branch of the Passaic River formed in Somerset and Morris Counties to the northwest. The Passaic Watershed, which in Union County includes parts of Berkeley Heights, New Providence, and Summit, is one of the major drainage basins in New Jersey. The watershed covers 935 square miles. Only 1 percent of this area is in Union County, and only 11 percent of the county, or an area of 11.4 square miles, drains into the Passaic River and its tributaries *(7)*.

The Rahway River traverses the central part of the county and forms the eastern boundary between Linden and Woodbridge in Middlesex County. The Rahway River drains the largest portion of the county, 44.9 square miles. Although this watershed encompasses 44 percent of Union County, its area in the county forms more than half of the total 81.9 square-mile Rahway Watershed. The Rahway Watershed crosses Union County in a generally north-south direction. It extends both north into Essex County to drain the Oranges and Maplewood area and south into Middlesex County to drain parts of Edison, Woodbridge, and Metuchen.

The Rahway River has three main branches. The headwaters of the main stem of the Rahway River formed in Essex County to the north. This branch enters the county in the Springfield and Union Township area and flows southeasterly through the county to the Arthur Kill. Robinsons Branch, one of the large tributaries, has its headwaters in Fanwood and Plainfield. This branch has a tributary area of 22 square miles, primarily within Union County. The south branch of the Rahway River is tributary to the main stem in the city of Rahway. The south branch lies mostly within Middlesex County *(6)*.

In the southwestern part of the county, Green Brook and Cedar Brook form a tributary system to the Raritan River. The headwaters of the Green Brook are in the Watchung Mountains of Union and Somerset Counties. The tributary area of the Green Brook at the southwest corner of the county is approximately 20 square miles, of which 6.7 square miles is within Union County. The headwaters of the Cedar Brook are in Scotch Plains and Fanwood; the tributary area where it leaves the county is approximately 5.3 square miles. The Union County portion of this basin forms 1 percent of the total 1,109.3 square miles of the Raritan drainage basin. This watershed extends south into Monmouth and Mercer Counties, west into Hunterdon County, and north into the Lake Hopatcong-Budd Lake area of Morris County.

The Elizabeth River drains nearly 14 percent of Union County, or an area of 14.5 square miles. The headwaters of the Elizabeth River formed in Essex County to the north. The Elizabeth River enters the county at the Union-Hillside line and flows southeasterly through Elizabeth to the Arthur Kill. The Elizabeth River basin is one of the most densely developed areas of the state.

The Morses Creek watershed lies entirely within Union County. It drains slightly over 11 percent of the county, or an area of 11.1 square miles. The remaining drainage system in the county is Bound Brook, which drains an area of 8.2 square miles.

Rapidly expanding urban and suburban development has disrupted natural drainage patterns. It has changed the way that soil absorbs water and how the water runs off the surface. Increased runoff from urban development has added to the potential for severe damage from flooding during periods of heavy rainfall. Union County, with aid from the Federal Government through the New Jersey Department of Environmental Protection, has designed and constructed many flood control facilities, such as detention basins and channel improvements. These projects are located on the Elizabeth River, Rahway River, and Morses Creek and its tributaries. The construction of detention basins and channel improvements has vastly reduced flood problems in Union County (7).

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area.

Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests, as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the

map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field, or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

As a result of changes in the classification of soils, particularly modifications or refinements in soil series concepts, and because of the range in slope in map units in different surveys, some of the boundaries and soil names on the general soil map of Union County do not match the boundaries and soil names on the previously published general soil maps of adjacent counties.

Soil Descriptions

1. Boonton-Urban land-Haledon

Gently sloping to moderately steep, moderately well drained and well drained soils that have a firm, loamy subsoil; Urban land; and nearly level to gently sloping, somewhat poorly drained soils that have a firm, loamy subsoil; on uplands of glacial till

This unit consists of areas of Urban land and soils on uplands of the terminal moraine in central Union County.

This unit makes up about 58 percent of Union County. The unit is about 25 percent Boonton soils, 25 percent Urban land, 20 percent Haledon soils, and 30 percent soils of minor extent.

Boonton soils are moderately well drained and well drained. They are gently sloping to moderately steep.

Urban land consists of commercial, industrial, and residential areas where more than 80 percent of the area is paved or built on. Most of the soil around building foundations and most of the fill material that is used to support buildings consist of Boonton and Haledon soils that have been cut or graded.

Haledon soils are somewhat poorly drained and are nearly level to gently sloping. They are in depressions, along water courses, and on toe slopes.

The minor soils in this unit are the well drained Birdsboro soils along old streams and outwash terraces; the somewhat poorly drained Raritan soils in low positions along streams and outwash terraces; the poorly drained, loamy Hasbrouck soils in depressions and nearly level, low areas of glacial till; the poorly drained, clayey Parsippany soils and the very poorly drained Carlisle and Adrian soils in depressions and old lake basins; and the well drained Neshaminy soils on side slopes of the Watchung Mountains.

Most of this unit is used for low-density residential developments. Other common uses are high-density commercial, industrial, and residential developments. Some areas are parkland. A fragipan restricts drainage through the soil. Ponding of water in depressions and flooding along swales occurs during seasons with heavy rainfall. Moderate to severe erosion is a hazard on the sloping areas.

2. Neshaminy-Amwell-Urban land

Gently sloping to steep, well drained, stony soils that have a cobbly subsoil; gently sloping and moderately sloping, moderately well drained and somewhat poorly drained soils that have a very firm, loamy subsoil; and Urban land, on uplands of residuum

This unit consists of areas of Urban land and soils on high ridges of the Watchung Mountains. The ridges generally have stepped side slopes with colluvium on the lower slopes and residuum on the upper slopes.

This unit makes up 7.5 percent of Union County. The unit is about 30 percent Neshaminy soils, 30 percent Amwell soils, 20 percent Urban land, and 20 percent soils of minor extent.

Neshaminy soils are well drained and gently sloping to steep. They are on side slopes and ridgetops.

Amwell soils are moderately well drained or somewhat poorly drained and are gently sloping and moderately sloping. They are on the toe slopes and the lower side slopes of the Watchung Mountains and in colluvial positions on knolls between drainageways.

Urban land consists of commercial, industrial, and residential areas where more than 80 percent of the area is paved or built on. Most of the soil around building foundations and most of the fill material that is used to support buildings consist of Neshaminy and Amwell soils that have been cut or graded.

The dominant minor soils in this unit are the moderately well drained Boonton soils, the somewhat poorly drained Haledon soils, and the poorly drained Hasbrouck soils. Other inclusions are areas of rock outcrop, areas of shallow or moderately deep soils, and areas of stone talus at the base of very steep slopes and rock escarpments.

Most of this unit is used for wooded parkland and open parkland. Some areas are used for low-density commercial, industrial, and residential development. The steep slopes and stoniness are limitations of these soils. In some areas a fragipan restricts drainage through the soil. A severe erosion hazard and soil creep are additional limitations in the steeper areas, especially in deep cuts for highways and other structures.

3. Urban land-Birdsboro-Raritan

Urban land; gently sloping, well drained, loamy soils; and nearly level, somewhat poorly drained soils that have a firm, loamy subsoil; on stratified terraces or glacial outwash

This unit consists of areas of Urban land and soils on outwash plains in western and central Union County and on terraces along some of the major streams throughout the rest of the county.

This unit makes up about 10 percent of Union County. The unit is about 30 percent Urban land, 27 percent Birdsboro soils, 8 percent Raritan soils, and 35 percent soils of minor extent.

Urban land consists of commercial, industrial, and residential areas where more than 80 percent of the area is paved or built on. Most of the soil around building foundations and most of the fill material that is used to support buildings consist of Birdsboro and Raritan soils that have been cut or graded.

Birdsboro soils are well drained and gently sloping. They are on terraces along the major streams and in the better drained positions on outwash plains.

Raritan soils are somewhat poorly drained and nearly level. They are on terraces along streams and in drainageways or depressional areas of outwash plains.

The minor soils in this unit are the well drained Dunellen soils on the high positions on outwash plains and terraces along streams; the somewhat poorly drained Dunellen soils in lower positions and along drainageways; the poorly drained Passaic soils in low wet areas; Udorthents, organic substratum (fill over muck), and waste substratum (sanitary landfill); and Udifluvents and Aquents along streams and on flood plains.

Most of this unit is used for industrial, commercial, or residential developments. Ponding of water, seasonal high water table, and hazard of flooding in low areas are limitations of these soils. The better drained areas and higher terraces have fewer, less severe limitations.

4. Urban land-Whippany-Parsippany

Urban land and nearly level to gently sloping, somewhat poorly drained and poorly drained soils that have a clayey subsoil; in old lake basins of glacial lacustrine material

This unit consists of Urban land and soils on broad, plane, low areas that are old glacial lake basins near the Passaic River in northwestern Union County.

This unit makes up 5.5 percent of Union County. The unit is about 25 percent Urban land, 15 percent Whippany soils, 10 percent Parsippany soils, and 50 percent soils of minor extent.

Urban land consists of commercial, industrial, and residential areas where more than 80 percent of the area is paved or built on. Most of the soil around building foundations and most of the fill material that is used to support buildings consist of Whippany and Parsippany soils that have been cut or graded.

Whippany soils are somewhat poorly drained and nearly level to gently sloping. They are on low mounds within or at the edges of basins of old glacial lakes.

Parsippany soils are poorly drained and nearly level. They are in depressions and basins of old glacial lakes.

The minor soils in this unit are the well drained Birdsboro soils along old stream and outwash terraces, the somewhat poorly drained Haledon soils in swales

that are underlain by glacial till, and the moderately well drained and somewhat poorly drained Amwell soils on the foot slopes of the Watchung Mountains.

Most of the better drained areas of this unit are used for commercial, industrial, or residential development. Most of the remaining open space is somewhat poorly drained and poorly drained and is used for drainage corridors through urban areas. Seasonal ponding of water, flooding along streams, and a high water table are limitations of these soils.

5. Carlisle-Adrian-Passaic-Dunellen

Level and nearly level, very poorly drained and poorly drained, mucky or clayey soils and gently sloping and moderately sloping, well drained, loamy soils; in basins or depressions of organic or fine lacustrine deposits and on terraces bordering the basins

This unit consists of areas of organic and mineral soils in depressions and low areas of basins of now extinct glacial lakes in central Union County. Areas of loamy soils on terraces border the basins.

This unit makes up about 3 percent of Union County. The unit is about 25 percent Carlisle and Adrian soils, 25 percent Passaic soils, 25 percent Dunellen soils, and 25 percent soils of minor extent.

Carlisle soils are very poorly drained and level. They are in low, swampy areas. Carlisle soils have a surface layer of highly decomposed black muck and a subsoil of dark reddish brown muck that extends to a depth of 60 inches or more.

Adrian soils are very poorly drained and level. They are mostly near the edges of low, swampy areas and in scattered areas where the mineral substratum is at a shallower depth. Adrian soils have a layer of black highly decomposed muck, underlain by very fine sand or gravelly loamy sand.

Passaic soils are poorly drained and nearly level. They are near the edges of low, swampy areas.

Dunellen soils are well drained and gently and moderately sloping. They are on low terraces bordering low, swampy areas.

The minor soils in this unit are the poorly drained, clayey Parsippany soils; areas of somewhat poorly drained, loamy soils; and areas of Urban land.

Most of this unit is used for wetlands, woodland, or wildlife habitat. A water table at or near the surface most of the year, and ponding or flooding during severe storms are the main limitations of these soils. Additional limitations result from the low position in the landscape and the absence of outlets for drainage systems.

6. Udorthents, organic substratum-Urban land-Sulfihemists-Sulfaquents

Level and nearly level areas of fill, Urban land, and tidal marsh; on old tidal marsh that has been covered with fill and in undisturbed tidal marsh

This unit consists of areas along the Arthur Kill, Newark Bay, and other major streams.

This unit makes up about 5.5 percent of Union County. The unit is about 55 percent Udorthents, organic substratum, 15 percent Urban land, 14 percent Sulfihemists and Sulfaquents, and 16 percent soils of minor extent.

Udorthents, organic substratum, are mostly areas of fill over tidal marsh. The depth and composition of the fill is variable. Extensive areas consist of material dredged from Newark Bay and the Arthur Kill.

Urban land consists of commercial, industrial, or residential areas where more than 80 percent of the area is paved or built on. Most of the soil around building foundations and material that is used to support buildings consist of fill over tidal marsh.

Sulfihemists are very poorly drained and are in nearly level tidal marsh areas. The soils have a very dark brown, fibrous, mucky surface layer; a yellowish brown, highly fibrous, organic subsoil; and a substratum that is a very dark grayish brown mixture of organic and mineral material.

Sulfaquents are very poorly drained and are in nearly level tidal marsh areas. The soils have a black, mucky and silty surface layer and a stratified and variable subsoil consisting of silty clay loam in most places, but ranging to gravelly loamy sand. The substratum in most places is gravelly and sandy.

The minor soils in this unit are primarily Udorthents and Udorthents, waste substratum.

Most of this unit is used for commercial and industrial development in the vicinity of Rahway, Elizabeth, and Newark. The soils are variable, depending on the kinds of fill used and the depth of the fill.

7. Urban land

Commercial, industrial, and residential areas where more than 80 percent is covered by buildings, pavement, or other structures

This unit makes up about 10.5 percent of Union County. The most extensive areas of Urban land are in the vicinity of Elizabeth, but Urban land is throughout the county. The underlying soils consist of any of the soils in the county. Included are areas of undisturbed soils and areas of fill.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Amwell silt loam, 3 to 8 percent slopes, is a phase of the Amwell series.

Some map units are made up of two or more major soils. These map units are called soil complexes, soil associations, or undifferentiated groups.

A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Boonton-Urban land-Haledon complex, gently sloping, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in the mapped areas are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Sulfihemists and Sulfaquents, frequently flooded, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Urban land is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

AmhB—Amwell silt loam, 3 to 8 percent slopes

This soil is gently sloping and somewhat poorly drained or moderately well drained. It is on middle and lower side slopes of the Watchung Mountains.

Typically, there are a few boulders, stones, and cobbles on the surface. The surface layer is dark brown, silt loam about 5 inches thick. The upper part of the subsoil is dark brown, mottled silt loam about 13 inches thick. The lower part of the subsoil is a fragipan of firm, brown, mottled silt loam about 14 inches thick. The substratum is firm, reddish brown, mottled silty clay loam. It extends to a depth of 60 inches.

Included with this soil in mapping are Neshaminy,

Haledon, Boonton, Parsippany, and Whippany soils; more sloping Amwell soils; moderately well drained soils with a gravelly and sandy substratum; and soils similar to this Amwell soil but with bedrock at a depth of less than 40 inches. The Neshaminy soils, the more sloping Amwell soils, and the soils that are less than 40 inches deep to bedrock are on the slopes of the Watchung Mountains. The Parsippany and Whippany soils and the moderately well drained soils are on toe slopes and along streams or waterways. The Haledon and Boonton soils are near Summit where the terminal moraine crosses the Watchung Mountains. Included soils make up about 20 percent of this unit.

The permeability of this Amwell soil is slow. Available water capacity is high. Runoff is medium and the hazard of erosion is moderate. A perched water table is at a depth of 12 to 48 inches from fall through early summer. Excess water moves laterally over the fragipan. Root penetration is limited by the fragipan. Reaction is extremely acid to moderately acid.

Most areas of this soil are used as woodland.

This soil is suited to use as woodland. The common trees are oak, beech, tulip, red maple, sweetgum, and ash. Potential productivity is fair, but there are limitations for woodland management. Slight limitations exist for equipment use, windthrow hazard, seedling mortality, and plant competition. Rooting depth is restricted by the fragipan.

The wetness and frost-action potential are the main limitations for urban use. The existence of a perched water table above the fragipan should be considered when designing drainage systems. Interceptor drains reduce the wetness and drain water from seeps and springs, especially near building foundations. Energy dissipaters at the end of each drainage pipe prevent gulling. Landscaping is limited to using plants that are tolerant of wetness and restricted rooting depth.

Capability subclass: IIe
Hydrologic group: C

AmhCb—Amwell silt loam, 8 to 15 percent slopes, very stony

This soil is moderately sloping and moderately well drained or somewhat poorly drained. It is on side slopes immediately below steep and very steep slopes at the shoulders of ridgetops in the Watchung Mountains.

Typically, there are many angular basalt stones on the surface. The surface layer is dark brown silt loam about 5 inches thick. The upper part of the subsoil is dark brown, mottled silt loam about 13 inches thick. The lower part of the subsoil is a fragipan of firm, brown, mottled silt loam about 14 inches thick. The substratum is firm, reddish brown, mottled silty clay loam. It extends to a depth of 60 inches.

Included with this soil in mapping are Boonton soils, Neshaminy soils, soils with an extremely stony surface, and soils that are less than 40 inches deep to bedrock. The Boonton soils are near the terminal moraine at the eastern border of the Watchung Reservation and at Summit. The remaining inclusions are on or near ridges. Included soils make up about 20 percent of this unit.

The permeability of this Amwell soil is slow. Available water capacity is high. Runoff is rapid, and the hazard of erosion is severe. A perched water table is at a depth of 12 to 48 inches from fall through early summer. Excess water moves laterally over the fragipan. Root penetration is limited by the pan. Reaction is extremely acid to moderately acid.

Most areas of this soil are used as woodland.

This soil is suited to use as woodland. The common trees are oak, beech, red maple, and sweetgum. Potential productivity is fair but limitations exist for equipment use. The other limitations are a windthrow hazard, seedling mortality, and plant competition (fig. 2).

The wetness, frost-action potential, and slope are limitations for urban use. Interceptor drains reduce the wetness and drain water from seeps and springs, especially near building foundations. Energy dissipaters at ends of drainage pipes prevent gulling.

This unit is limited for lawns and landscaping by slope and surface stones. Excavations will intercept laterally flowing ground water above the fragipan. Landscaping is limited to using plants that are tolerant of wetness and restricted rooting depth.

Capability subclass: IVs
Hydrologic group: C

AmuB—Amwell-Urban land complex, 0 to 8 percent slopes

This unit consists mostly of moderately well drained or somewhat poorly drained Amwell soils and areas of Urban land. Slopes are dominantly 3 to 8 percent but range to 15 percent in some areas. The areas of this unit are 50 percent Amwell soils, 30 percent Urban land, and 20 percent other soils.

Typically, the surface layer of Amwell soils is dark brown silt loam about 5 inches thick. The upper part of the subsoil is dark brown, mottled silt loam about 13 inches thick. The lower part of the subsoil is a fragipan

Figure 2.—Shallow rooting depth from a fragipan caused windthrow of trees on Amwell silt loam, 8 to 15 percent slopes, very stony.

of firm, brown, mottled silt loam about 14 inches thick. The substratum is firm, reddish brown, mottled silty clay loam. It extends to a depth of 60 inches.

The Urban land part of the unit is covered by streets, driveways, buildings, and other impervious structures that obscure or alter the soil so that soil identification is not feasible.

Included with this unit in mapping are Udorthents, loamy; Haledon, Whippany, and Neshaminy soils; fine textured soils that are underlain at a shallow depth by shale bedrock; and soils similar to this Amwell soil but that have a gravelly substratum. The Udorthents are in areas of cut and fill. The Neshaminy soils and soils with a gravelly substratum are on steep side slopes near the ridgetops of the Watchung Mountains. The Haledon soils are slightly coarser textured and are where the terminal moraine crosses the Watchung Mountains. Fine textured Whippany soils are on the toe slopes mainly in the Passaic Basin. The fine textured soils underlain by shale bedrock are along Springfield Avenue at the border of Berkeley Heights and New Providence. Included soils make up about 20 percent of this unit.

The permeability of this Amwell soil is slow. Available water capacity is high. Runoff is rapid, and the erosion hazard is severe. A perched water table is at a depth of 12 to 48 inches from fall through early summer. Excess water moves laterally over the fragipan. Root penetration is limited by the pan. Reaction is extremely acid to moderately acid.

This unit is in developed, mainly residential areas. The open portions of this unit are used for lawns, gardens, and small parks.

Perched water above the fragipan is limiting for lawns, gardens, and building sites. Drainage is needed, but selection of a method requires onsite investigation. The most suitable plants are perennials with a tolerance for wetness. Gully erosion from storm water runoff is a hazard.

Capability subclass: not assigned

Hydrologic group: C (Amwell part)

BhnB—Birdsboro silt loam, 3 to 8 percent slopes

This soil is gently sloping and well drained. It is formed in water-deposited glacial outwash of kames and old stream outwash.

Typically, the surface layer is very dark brown silt loam about 4 inches thick, underlain by dark brown silt loam about 8 inches thick. The upper part of the subsoil is brown gravelly loam about 6 inches thick. The lower part of the subsoil is reddish brown gravelly sandy clay loam about 20 inches thick. The substratum, to a depth of 60 inches, is reddish brown very gravelly loamy sand.

Included with this soil in mapping are Dunellen soils, soils that have a gravelly and sandy substratum at a depth of 20 to 40 inches, and Raritan soils. The Dunellen soils and the soils with a gravelly and sandy substratum are on steeper slopes. The Raritan soils are mainly in depressions or swales, on flats, and along drainageways. Included soils make up about 20 percent of this unit.

The permeability of this Birdsboro soil is moderate in the surface layer and subsoil and rapid in the substratum. A water table is dominantly at a depth of more than 40 inches from fall through late spring but may be at 24 inches in some areas. Available water capacity is high. Runoff is medium, and the hazard of erosion is moderate. The root zone is deep. Flooding is rare. Reaction is extremely acid to strongly acid.

Most areas of this soil are used as woodland.

This soil is well suited for woodland use. The common trees are northern red oak and yellow poplar and lesser amounts of beech and ash.

This soil is suited for most urban uses. The main limitations are rare flooding hazard, rapid permeability of the substratum and a potential for ground-water pollution, and moderate frost-action potential.

This unit is well suited for lawns and landscaping if the surface layer and subsoil are undisturbed. When the sandy materials of the substratum are exposed, the soil is droughty.

Capability subclass: IIe
Hydrologic group: B

BhpB—Birdsboro-Urban land complex, 0 to 8 percent slopes

This unit consists mostly of well drained Birdsboro soils and areas of Urban land. Slopes are 0 to 8 percent. The areas of this unit contain 50 percent Birdsboro soils, 40 percent Urban land, and 10 percent other soils. The component of Urban land is larger near municipal, commercial, and transportation-corridor areas.

Typically, the surface layer of Birdsboro soils is very dark brown silt loam about 4 inches thick, underlain by dark brown silt loam about 8 inches thick. The upper part of the subsoil is brown gravelly loam about 6 inches thick. The lower part of the subsoil is reddish brown, gravelly sandy clay loam about 20 inches thick. The substratum is reddish brown, very gravelly loamy sand to a depth of 60 inches.

The Urban land part of the unit is covered by streets, driveways, parking lots, buildings, and other impervious structures that obscure or alter the soils so that soil identification is not feasible.

Included with this unit in mapping are Dunellen, Boonton, and Raritan soils and Udorthents, loamy. The Dunellen soils are coarse textured. They are on the steeper slopes and along the western border of this unit in the Plainfield area. The Boonton soils are in map units near the terminal moraine in Plainfield and at the border between kame and outwash areas and glacial till, mainly in Kenilworth, Union, and Hillside. The Raritan soils are in depressions and along drainageways. Udorthents are in areas of cut or fill. Included soils make up about 20 percent of this unit.

The permeability of this Birdsboro soil is moderate in the surface layer and subsoil and rapid in the substratum. A water table is dominantly at a depth of more than 40 inches from fall through late spring but may be at 24 inches in some areas. Available water capacity is high. Runoff is medium and the hazard of erosion is moderate. The root zone is deep. Flooding is rare. Reaction is extremely acid to strongly acid.

This unit is in extensively developed residential, commercial, and industrial areas. The open portion of this unit is used for lawns, gardens, open space, and small parks.

The complex is suited for urban use. The main limitation is a hazard of ground-water pollution caused by the permeability of the substratum. In areas adjacent to Greenbrook in Plainfield, rare flooding is a hazard. The soil is well suited for lawns, gardens, trees, and shrubs.

Capability subclass: not assigned.
Hydrologic group: B (Birdsboro part)

BogB—Boonton loam, 3 to 8 percent slopes

This soil is gently sloping and well drained or moderately well drained. It is on convex slopes of glacial till.

Typically, there are a few stones of sandstone, shale, gneiss, or basalt on the surface. The surface layer is dark grayish brown loam about 8 inches thick, underlain by brown gravelly loam about 4 inches thick. The upper part of the subsoil is brown gravelly fine sandy loam about 12 inches thick. The middle part of the subsoil is reddish brown, mottled gravelly fine sandy loam about 12 inches thick. The lower part is a fragipan of very firm, reddish brown loam to a depth of 60 inches.

Included with this soil in mapping are fine-loamy soils that are similar to Boonton soils and Haledon, Birdsboro, Dunellen, Hasbrouck, and Carlisle soils. The Haledon, Hasbrouck, and Carlisle soils are in small depressions, swales, and drainageways. The Birdsboro and Dunellen soils are near stream terraces and in areas bordering outwash and kames. The fine-loamy soils are in the eastern part of the county. Also included are soils with steeper slopes, soils with a stony surface, and soils where basalt bedrock is within 4 feet of the surface. The soils with a stony surface are in the area of Summit, and boulders are on some of those areas. The soils with basalt bedrock within 4 feet are on top of the First Watchung Mountain in Summit and Springfield. Included soils make up about 15 percent of this unit.

The permeability of this Boonton soil is moderate in the surface layer and upper parts of the subsoil and very slow to slow in the fragipan. Available water capacity is moderate. Runoff is medium, and the hazard of erosion is moderate. After heavy rains and in winter and early spring, a perched water table is at a depth of 18 to 36 inches. Root penetration is restricted by the fragipan. Reaction is very strongly acid to moderately acid.

This soil is mainly woodland. The common trees are red and white oaks, yellow poplar, and white ash. Rooting depth is restricted by the fragipan.

This soil is limited for many urban uses by a perched water table, slow percolation rates, and frost-action potential. In addition, concentrated runoff and seepage water from higher surrounding areas are major limitations. Lateral seepage along the top of the fragipan commonly enters excavations, making the soil unstable at steep cuts for roads and building sites. Interceptor drains are needed around foundations to remove excess water and are also effective at the tops of slopes and retaining walls.

This soil is well suited for lawns and landscaping.

Capability subclass: IIe

Hydrologic group: C

BohC—Boonton gravelly loam, 8 to 15 percent slopes

This soil is moderately sloping and well drained or moderately well drained. It is on convex glacial till landscapes, mainly in the terminal moraine area. Pebbles, cobbles, and stones of sandstone, shale, gneiss, conglomerate, and basalt are common in the soil. Boulders are rare. Basalt coarse fragments are more abundant in the vicinity of the Watchung Mountains, and sandstone, shale, and gneiss coarse fragments are more common in other areas of the county.

Typically, there are a few stones of sandstone, shale, gneiss, or basalt on the surface. The surface layer is very dark grayish brown gravelly loam about 3 inches thick, underlain by brown gravelly loam about 9 inches thick. The upper part of the subsoil is brown gravelly fine sandy loam about 12 inches thick. The middle part of the subsoil is reddish brown, mottled gravelly fine sandy loam about 12 inches thick. The lower part is a fragipan of very firm, reddish brown loam to a depth of 60 inches.

Included with this soil in mapping are Haledon soils, Amwell soils, bedrock outcrops, and extremely stony soils. The Haledon and Amwell soils are in small depressions and along drainageways. The Amwell soils, bedrock outcrop, and extremely stony soils are on the side slopes of the Watchung Mountains. Included soils make up about 20 percent of this unit.

The permeability of this Boonton soil is moderate in the surface layer and upper parts of the subsoil and very slow to slow in the fragipan. Available water capacity is moderate. Runoff is medium, and the hazard of erosion is severe. After heavy rains, and in winter and early spring, a perched water table is at a depth of 18 to 36 inches. Seeps are common where ground water flows along the top of the fragipan. Root penetration is restricted by the fragipan. Reaction is very strongly acid to moderately acid.

This soil is mainly used as woodland. The common trees are red and white oaks, yellow poplar, and white ash. Rooting depth is restricted by the fragipan.

This soil is severely limited for urban use by slope and the fragipan. In addition, lateral seepage along the top of the fragipan commonly enters excavations, making the soil unstable at steep cuts for roads and building sites.

The slope severely limits this unit for lawns and landscaping. Interceptor drains will remove or reduce laterally flowing ground water over the fragipan during

site preparation. This soil may become droughty during extended dry periods during summer.

Capability subclass: IIIe

Hydrologic group: C

BohD—Boonton gravelly loam, 15 to 25 percent slopes

This soil is moderately steep and well drained. It is on convex slopes of glacial till mainly in the terminal moraine area. Cobbles and stones of sandstone, shale, gneiss, conglomerate, and basalt are more prevalent on the surface of the steeper areas. Basalt stones dominate the surface in the area of Summit; sandstone, shale, and gneiss dominate in other areas.

Typically, there are a few stones of sandstone, shale, gneiss, or basalt on the surface. The surface layer is very dark grayish brown gravelly loam about 3 inches thick, underlain by brown gravelly loam about 9 inches thick. The upper part of the subsoil is brown gravelly fine sandy loam about 12 inches thick. The middle part of the subsoil is reddish brown, mottled gravelly fine sandy loam about 12 inches thick. The lower part is a fragipan of very firm, reddish brown loam to a depth of 60 inches.

Included with this soil in mapping are Haledon soils, Amwell soils, similar soils that are less than 4 feet deep to bedrock, bedrock outcrops, and soils with an extremely stony surface. The Haledon and Amwell soils in small depressions, on toe slopes, and in drainageways. The bedrock outcrops and soils that are less than 4 feet to bedrock or have extremely stony surface are on the shoulders of side slopes in the Watchung Mountains. Included soils make up about 20 percent of this unit.

The permeability of this Boonton soil is moderate in the surface layer and upper parts of the subsoil and very slow to slow in the fragipan. Available water capacity is moderate. Runoff is rapid, and the hazard of erosion is severe. After heavy rains and in winter and early spring, a perched water table is at a depth of 18 to 36 inches. Seeps are common where ground water flows along the top of the fragipan. Root penetration is restricted by the fragipan. Reaction is very strongly acid to moderately acid.

This soil is mainly used as woodland. The common trees are red and white oaks, yellow poplar, and white ash. Rooting depth is restricted by the fragipan.

This soil is severely limited for urban use by slope and the fragipan. In addition, lateral seepage along the top of the fragipan commonly enters excavations, making the soil unstable at steep cuts for roads and building sites.

This unit is severely limited for lawns and landscaping by slope. Interceptor drains will remove or reduce laterally flowing ground water over the fragipan during site preparation. This soil may become droughty during extended dry periods during summer.

Capability subclass: IVe

Hydrologic group: C

BovB—Boonton-Urban land-Haledon complex, 0 to 8 percent slopes

This unit consists mostly of well drained or moderately well drained Boonton soils, areas of Urban land, and somewhat poorly drained Haledon soils. The Boonton soils generally are on convex slopes of 3 to 8 percent. The Haledon soils are on nearly level toe slopes of 0 to 3 percent. The areas of Urban land are throughout the unit. The areas of this unit contain 45 percent Boonton soils, 25 percent Urban land, 20 percent Haledon soils, and 10 percent other soils. The component of Urban land is larger in areas adjacent to municipal, commercial, and transportation-corridor areas.

Typically, the surface layer of Boonton soils is dark grayish brown loam about 8 inches thick, underlain by brown gravelly loam about 4 inches thick. The upper part of the subsoil is brown gravelly fine sandy loam about 12 inches thick. The middle part of the subsoil is reddish brown, mottled gravelly fine sandy loam about 12 inches thick. The lower part is a fragipan of very firm, reddish brown loam to a depth of 60 inches.

The Urban land part of the unit is covered by streets, driveways, parking lots, buildings, and other impervious structures that obscure or alter the soils so that soil identification is not feasible.

Typically, the surface layer of Haledon soils is dark grayish brown loam about 9 inches thick. The upper part of the subsoil is yellowish brown loam about 7 inches thick. The middle part of the subsoil is yellowish brown, mottled silt loam about 12 inches thick. The lower part of the subsoil is a fragipan of firm, reddish brown, mottled sandy loam about 16 inches thick. The substratum is dark yellowish brown, very firm gravelly loam to a depth of 60 inches.

Included with this unit in mapping are Hasbrouck, Amwell, Neshaminy, Dunellen, Birdsboro, Raritan, and Whippany soils and Udorthents, loamy. The Udorthents are in areas of cut and fill. Generally, the more sloping Boonton soils have been cut, and the nearly level areas of Haledon soils have been filled. The Hasbrouck soils are in small depressions and along drainageways. The Amwell and Neshaminy soils are near the Watchung Mountains. The Neshaminy

soils are on mountain ridges. The Amwell soils are on side slopes. The Dunellen, Raritan, and Birdsboro soils are in glacial till areas that are in contact with outwash, stream terraces, and kames. The Whippany soils are in drainageways and basins in the northern sections of Summit and Springfield where glacial till is in contact with lacustrine areas. Included soils make up about 10 percent of this unit.

The permeability of this Boonton soil is moderate in the surface layer and upper parts of the subsoil, and very slow to slow in the fragipan. Available water capacity is moderate. Runoff is medium, and the hazard of erosion is moderate. After heavy rains and in winter and early spring, a perched water table is at a depth of 18 to 36 inches. Seeps are common where ground water flows along the top of the fragipan. Root penetration is restricted by the fragipan. Reaction is very strongly acid to moderately acid.

The permeability of this Haledon soil is moderate above the fragipan but is slow in the fragipan. A perched water table is at a depth of 6 to 18 inches from winter through late spring. Excess water moves laterally over the fragipan. Available water capacity is moderate. Runoff is slow, and the hazard of erosion is slight. Root penetration is restricted by the fragipan. Reaction is very strongly acid.

This unit is in extensively developed areas used for residential, commercial, or industrial purposes. The open portions are used for lawns, gardens, open space, and small parks.

This unit has limitations for building sites and other engineering uses. Many areas require drainage to protect against damage to structures such as foundations and retaining walls. Lateral seepage along the top of the fragipan commonly surfaces in excavations and cuts, making the soils unstable. Drainage at the top of the slopes can help prevent the seepage. Frost action commonly is a hazard for roads.

Wetness limits this unit for lawns, gardens, trees, and shrubs. Drainage is needed to remove excess water in the Haledon soils. Onsite investigation is needed to determine the drainage method. Landscaping is limited in most areas to using plants that are tolerant of wetness.

Capability subclass: not assigned.

Hydrologic group: C (Boonton and Haledon parts)

BouD—Boonton-Urban land complex, 15 to 25 percent slopes

This unit consists mostly of well drained or moderately well drained Boonton soils and areas of Urban land. Slopes are dominantly 15 to 25 percent, but range from 8 to 25 percent in some areas. The areas of this unit contain 50 percent Boonton soils, 20 percent Urban land, and 30 percent other soils.

Typically, the surface layer of the Boonton soils is very dark grayish brown gravelly loam about 3 inches thick, underlain by brown gravelly loam about 9 inches thick. The upper part of the subsoil is brown gravelly fine sandy loam about 12 inches thick. The middle part of the subsoil is reddish brown, mottled gravelly fine sandy loam about 12 inches thick. The lower part is a fragipan of very firm, reddish brown loam to a depth of 60 inches.

The Urban land portion of this unit is covered by streets, driveways, buildings, and other impervious structures that obscure or alter the soil so that soil identification is not feasible.

Included with this unit in mapping are Haledon soils and Udorthents, loamy. The Haledon soils are on level and gently sloping areas, and the Udorthents are in areas of cut and fill. Also included are Amwell, Carlisle, and Hasbrouck soils and Aquents, frequently flooded. The Amwell soils are where the terminal moraine crosses the Watchung Mountains. The Carlisle muck, the Hasbrouck soils, and the Aquents are along drainageways. Included soils make up about 30 percent of this unit.

The permeability of this Boonton soil is moderate in the surface layer and upper parts of the subsoil and very slow to slow in the fragipan. Available water capacity is moderate. Runoff is rapid, and the hazard of erosion is severe. After heavy rains and in winter and early spring, a perched water table is at a depth of 18 to 36 inches and flows laterally on top of the fragipan. Seeps are common where ground water flows along the top of the fragipan. Root penetration is restricted by the fragipan. Reaction is very strongly acid to moderately acid.

This unit is in developed, mainly residential areas. The open portions of this unit are used for lawns, trees, and shrubs.

This unit has severe limitations for building sites because of slope and wetness. Drainage is needed in all nearly level areas to remove excess water, but a lack of suitable outlets makes onsite investigation necessary.

Areas must be drained to protect against damage to structures such as foundations and retaining walls. Lateral seepage along the top of the fragipan commonly enters excavations, making the soil unstable at steep cuts. Drainage at the top of these slopes helps to prevent seepage. Severe damage to roads by frost action is common. The better drained

soils in this unit may become droughty during summer dry periods.

Capability subclass: not assigned.

Hydrologic group: C (Boonton part)

Cara—Carlisle-Adrian mucks

This unit consists of very deep, very poorly drained Carlisle and Adrian mucks. These soils are swamps in basins and depressions filled with sediments and organic material. Slopes are 0 to 2 percent. Carlisle soils are dominant in the numerous other small depressions throughout the glacial till areas of the county. Carlisle soils are also extensive in old glacial lake areas such as in Lenape, Galloping Hill, and Ashbrook Parks and Reservations. Adrian soils are mostly near the edges of this unit where the organic soils grade into mineral soils. Adrian soils are also in areas where the depth to the mineral soil is typically about 2 feet. The areas of this unit contain 65 percent Carlisle muck, 25 percent Adrian muck, and 10 percent other soils.

Typically, the upper 8 inches of Carlisle soils is black, highly decomposed muck. The next 7 inches is black, decomposed muck with dark reddish brown partially decomposed fibers. Below this is dark reddish brown muck with an increase in fiber content that extends to a depth of 60 inches or more.

Typically, the upper 24 inches of Adrian soils is black, highly decomposed muck. The upper part of the substratum is stratified, light brownish gray and dark gray sand about 8 inches thick. The lower part of the substratum is mottled and stratified with reddish brown loamy fine sand and fine sandy loam to a depth of 60 inches.

Included with this unit in mapping are Fluvaquents, frequently flooded, along streams and Passaic soils. The Passaic soils are on slightly higher areas surrounded by Carlisle and Adrian soils and near the edges of the unit. Included soils make up about 10 percent of the unit.

The permeability of the Carlisle and Adrian soils is moderately rapid or rapid. A water table is at or near the surface most of the time. Available water capacity is high. Runoff is very slow, and the hazard of erosion is slight. These soils have low bearing capacity. Most areas are flooded. Reaction is moderately acid to neutral.

Most areas of this soil are wooded or in drained golf fairways.

This unit is poorly suited for use as woodland because of windthrow hazard, and equipment limitations due to the low bearing capacity and the high water table. The common trees are red maples, swamp white oak, silver maple, white and green ash, and quaking aspen.

This unit is severely limited for community development by the high water table, the flooding hazard, and poor trafficability.

This unit is severely limited for lawns and landscaping by wetness, excess humus, and flooding. These soils are compressible and unstable under load. Drainage is often hindered by a lack of suitable outlets. Subsidence will occur when the soil is drained. Landscaping is limited to using plants that are tolerant of wetness.

If not drained, these soils are best suited for wildlife habitat and for water storage and recharge.

Capability subclass: IIIw and IVw

Hydrologic group: D

DunB—Dunellen sandy loam, 3 to 8 percent slopes

This soil is gently sloping and well drained. It is on side slopes of glacial outwash and stream terraces.

Typically, the surface layer is dark brown sandy loam about 4 inches thick. The subsurface layer is brown sandy loam about 4 inches thick. The subsoil is yellowish red sandy loam about 22 inches thick. The upper part of the substratum is yellowish red loamy sand about 28 inches thick. The lower part of the substratum is reddish brown loamy fine sand to a depth of 60 inches.

Included with this soil in mapping are Birdsboro, Tunkhannock, and Raritan soils; Dunellen soils with a surface layer of loam, gravelly sandy loam, or silt loam; and moderately well drained soils with a contrasting stratified gravelly and sandy substratum. The Raritan soils and the moderately well drained soils are on nearly level slopes. The Tunkhannock soils are on isolated low mounds and long low ridges. Included soils make up about 20 percent of this map unit.

The permeability of this Dunellen soil is moderate in the surface layer and subsoil and rapid in the substratum. Available water capacity is moderate. Runoff is slow, and the hazard of erosion is moderate. Effective rooting depth is deep. Reaction is very strongly acid to moderately acid.

Most areas of this soil are wooded.

This soil is suited for woodland use. The common trees are oaks and minor amounts of maple, black cherry, birch, beech, and sweet gum. A major limitation is the available water capacity during summer.

This soil is well suited for urban use. The rapid permeability in the substratum causes a hazard of

ground-water pollution. Excavation sidewalls are unstable.

This soil is well suited for lawns and landscaping if the upper part of the soil is left intact. The plant cover is more difficult to maintain if the sandy substratum is exposed.

Capability subclass: IIe

Hydrologic group: B

DuuA—Dunellen-Urban land complex, 0 to 3 percent slopes

This unit consists mostly of well drained Dunellen soils with a wet substratum and areas of Urban land. Slopes are 0 to 3 percent. The areas of this unit contain 50 percent Dunellen soils with a wet substratum, 30 percent Urban land, and 20 percent other soils.

Typically, the surface layer of Dunellen soils is dark brown sandy loam about 3 inches thick. The subsurface layer is brown sandy loam about 5 inches thick. The subsoil is reddish brown sandy loam about 22 inches thick. The upper part of the substratum is yellowish red, mottled sandy loam about 14 inches thick. The lower part of the substratum is a weak red, mottled loamy sand to a depth of 60 inches.

The Urban land part of the unit is covered by streets, driveways, buildings, and other impervious structures that obscure or alter the soils so that identification is not feasible.

Included with this unit in mapping are areas of Birdsboro, Raritan, and Whippany soils and Udorthents, loamy, and Fluvaquents, frequently flooded. The Birdsboro soils are in the area of Plainfield. The Fluvaquents are adjacent to waterways or streams. The Whippany soils are finer textured and are mainly in the Passaic Basin. The Udorthents are in areas of cut and fill. Included soils make up about 20 percent of this map unit.

The permeability of this Dunellen soil is moderate in the surface layer and subsoil and rapid in the substratum. Available water capacity is moderate. A water table is at a depth of 48 to 72 inches from late winter through spring. Runoff is slow, and the hazard of erosion is moderate. Effective rooting depth is deep. Reaction is very strongly acid to moderately acid.

This unit is in extensively developed, mainly residential areas.

This unit is limited for urban use by the rapid permeability of the substratum, which causes a hazard of ground-water pollution, and by wetness in the substratum. Tile drainage systems effectively move excess water away from buildings. Sidewalls are unstable in excavations and need to be shored.

This unit is suited for lawns and landscaping with wetness-tolerant plants. Drainage is difficult to apply.

Capability subclass: not assigned.

Hydrologic group: B (Dunellen part)

DuuB—Dunellen-Urban land complex, 3 to 8 percent slopes

This unit consists mostly of well drained Dunellen soils and areas of Urban land. Slopes are dominantly 3 to 8 percent but range to 15 percent in some areas. The areas of this unit contain 55 percent Dunellen soil, 35 percent Urban land, and 10 percent other soils. The component of Urban land is larger in areas adjacent to municipal, commercial, and transportation-corridor areas.

Typically, the surface layer of Dunellen soils is dark brown sandy loam about 4 inches thick. The subsurface layer is brown sandy loam about 4 inches thick. The subsoil is yellowish red sandy loam about 22 inches thick. The upper part of the substratum is yellowish red loamy sand about 28 inches thick. The lower part of the substratum is a reddish brown loamy fine sand to a depth of 60 inches.

The Urban land part of the unit is covered by streets, driveways, parking lots, buildings, and other impervious structures that obscure or alter the soils so that identification is not feasible.

Included with this unit in mapping are Birdsboro, Boonton, and Raritan soils, Udorthents, loamy, and moderately well drained soils with a contrasting stratified gravelly and sandy substratum. The somewhat poorly drained Raritan soils and moderately well drained soils are in low positions and nearly level areas. The Birdsboro soils are mainly in the eastern part of units in Plainfield and in random areas elsewhere in the county. The Udorthents are in areas of cut and fill. The Boonton soils are where kame areas border with glacial till, primarily in Kenilworth, Union, and Hillside. Included soils make up about 10 percent of this map unit.

This unit is in extensively developed areas used for residential, commercial, and industrial purposes. The open portion of this unit is used for lawns, gardens, open space, and small parks.

The permeability of this Dunellen soil is moderate in the surface layer, subsurface layer, and subsoil, and rapid in the substratum. Available water capacity is

moderate. Runoff is slow, and the hazard of erosion is moderate. Effective rooting depth is deep. Reaction is very strongly acid to moderately acid.

This soil is well suited for urban use. The most limiting characteristic is the rapid permeability of the substratum, which causes a hazard of ground-water pollution.

The soil is well suited for lawns, gardens, trees, and shrubs.

Capability subclass: not assigned.

Hydrologic group: B (Dunellen part)

DuuD—Dunellen-Urban complex, 15 to 25 percent slopes

This unit consists mostly of well drained Dunellen soils and areas of Urban land. Slopes are 15 to 35 percent. The areas of this unit contain 55 percent Dunellen soils, 30 percent Urban land, and 15 percent other soils.

Typically, the surface layer of Dunellen soils is dark brown sandy loam about 4 inches thick. The subsurface layer is brown sandy loam about 4 inches thick. The subsoil is yellowish red sandy loam about 22 inches thick. The upper part of the substratum is yellowish red loamy sand about 28 inches thick. The lower part of the substratum is a reddish brown loamy fine sand to a depth of 60 inches.

The Urban land part of the unit is covered by streets, driveways, and homes that obscure or alter the soils so that identification is not feasible.

Included with this unit in mapping are Udorthents, loamy, Boonton soils, Birdsboro soils, and moderately well drained soils with a contrasting stratified gravelly and sandy substratum. The Birdsboro soils and moderately well drained soils are on less steep slopes. The Udorthents are in areas of cuts and fills. The Boonton soils are where kame areas border glacial till, mainly in Kenilworth and Union. Included soils make up about 15 percent of this map unit.

The permeability of this Dunellen soil is moderate in the surface layer, subsurface layer, and subsoil and rapid in the substratum. Available water capacity is moderate. Runoff is rapid, and the hazard of erosion is severe. Effective rooting depth is deep. Reaction is very strongly acid to moderately acid.

This unit is in extensively developed, mainly residential areas. Open areas of this unit are idle land.

This soil is limited for landscaping and urban use by the rapid permeability of the substratum, which causes a hazard of ground-water pollution, and by the severe erosion hazard.

Capability subclass: not assigned.

Hydrologic group: B (Dunellen part)

Fmt—Fluvaquents, frequently flooded

These soils are somewhat poorly drained or poorly drained. Slopes are 0 to 3 percent. The soils are along streams of the Rahway and Greenbrook River systems and consist of stratified loamy sediments and organic materials. A water table is between the surface and a depth of 18 inches from fall to early summer.

Included with these soils in mapping are Passaic, Carlisle, and Raritan soils. The Passaic and Carlisle soils are in depressions and old stream meander scars on the flood plains. The Raritan soils are mainly along the margins of the flood plains in areas that do not flood frequently. Included soils make up about 25 percent of this unit.

These soils have not been extensively developed because of the flooding hazard and the high water table. In some areas, dikes and other flood control projects have been built or are underway. This unit is severely limited for lawns and landscaping by frequent flooding and wetness.

Capability subclass: Vw

Hydrologic group: B/D

HakA—Haledon loam, 0 to 3 percent slopes

This soil is nearly level and somewhat poorly drained. It is in depressions on the terminal moraine and in waterways on uplands. Slopes are simple or concave.

Typically, the surface layer of Haledon soils is dark grayish brown loam about 9 inches thick. The upper part of the subsoil is yellowish brown loam about 7 inches thick. The middle part of the subsoil is yellowish brown, mottled silt loam about 12 inches thick. The lower part of the subsoil is a fragipan of firm, reddish brown, mottled sandy loam about 16 inches thick. The substratum is dark yellowish brown, very firm gravelly loam to a depth of 60 inches.

Included with this soil in mapping are Boonton and Hasbrouck soils. Also included are soils with a stony surface, Dunellen soils, and Passaic soils. The Boonton soils are on low mounds and side slopes. The Hasbrouck and Passaic soils are in small isolated depressions and drainageways. The Dunellen soils are in random small areas. The soils with a stony surface are mainly in poorly defined waterways extending up the side slopes of the Watchung Mountains near Summit. Included soils make up about 20 percent of this map unit.

The permeability of this Haledon soil is moderate above the fragipan but is slow in the fragipan. A perched water table is at a depth of 6 to 18 inches

from winter through late spring. Excess water moves laterally over the fragipan. Available water capacity is moderate. Runoff is slow, and the hazard of erosion is slight. Root penetration is restricted by the fragipan. Reaction is very strongly acid.

Many areas of this unit are woodland. Others are in golf courses or open park areas.

This soil is suited to use as a woodland. Potential productivity is fair. There are moderate limitations for equipment, seedling mortality, and plant competition. Rooting depth is restricted by the firm fragipan. The common trees are red maple, sweetgum, pin and white oak, and white ash.

This soil is limited for urban use by the slow permeability in the fragipan, the seasonal perched water table, and frost-action potential. Use of a temporary grass cover to protect cleared areas during construction, early establishment of grass cover, and division of long slopes by use of diversions or cross streets, help to control erosion and runoff. Construction of sedimentation basins and installation of interceptor drains also help to control erosion.

Wetness is a severe limitation affecting lawns and landscaping due to a perched water table and runoff from surrounding higher areas. Drainage design should consider the existence of a fragipan. Suitable outlets for drainage are limited in many areas. Landscaping is limited to using plants that are tolerant of wetness and restricted rooting depth.

Capability subclass: IIIw

Hydrologic group: C

HakB—Haledon loam, 3 to 8 percent slopes

This soil is gently sloping and somewhat poorly drained. It is mainly on the toe slopes of the terminal moraine and on low convex landscapes.

Typically, the surface layer of Haledon soils is dark grayish brown loam about 9 inches thick. The upper part of the subsoil is yellowish brown loam about 7 inches thick. The middle part of the subsoil is yellowish brown, mottled silt loam about 12 inches thick. The lower part of the subsoil is a fragipan of firm, reddish brown, mottled sandy loam about 16 inches thick. The substratum is dark yellowish brown, very firm gravelly loam to a depth of 60 inches.

Included with this soil in mapping are Boonton, Amwell, and Hasbrouck soils. Also included are Whippany, Raritan, and Dunellen soils. The Boonton and Amwell soils are on slopes of more than 3 percent. The Hasbrouck soils are mainly in depressions. The Whippany, Raritan, and Dunellen soils are near outwash plains. Included soils make up about 20 percent of this map unit.

The permeability of this Haledon soil is moderate above the fragipan but is slow in the fragipan. A perched water table is at a depth of 6 to 18 inches from winter through late spring. Excess water moves laterally over the fragipan. Available water capacity is moderate. Runoff is slow, and the hazard of erosion is moderate. Root penetration is restricted by the fragipan. Reaction is very strongly acid.

Many undeveloped areas of this unit are woodland. Other areas are in golf courses and parkland.

This soil is suited to use a woodland. Potential productivity is fair. There are moderate limitations for equipment, seedling mortality, and plant competition. Rooting depth is restricted by the firm fragipan. The common trees are oak, red maple, white ash, sweetgum, and beech.

This soil is limited for urban use by the slow permeability in the fragipan, the seasonal perched water table, and frost-action potential. Use of temporary grass cover to protect cleared areas during construction, early establishment of grass cover, and division of long slopes by use of diversions or cross streets help to control erosion and runoff.

This unit is limited for lawns and landscaping by wetness due to the perched water table. Drainage design should consider the existence of a fragipan and the potential for interception of laterally flowing ground water above the fragipan. Landscaping is limited to using plants that are tolerant of wetness and restricted rooting depth.

Capability subclass: IIIe

Hydrologic group: C

HatB—Haledon-Urban land-Hasbrouck complex, 0 to 8 percent slopes

This unit consists mostly of somewhat poorly drained Haledon soils, areas of Urban land, and poorly drained Hasbrouck soils. Haledon soils are on both the convex and nearly level slopes of 0 to 8 percent. Hasbrouck soils are in depressions and along drainageways on slopes of 0 to 2 percent. The areas of this unit contain 40 percent Haledon soils, 30 percent Urban land, 20 percent Hasbrouck soils, and 10 percent other soils. The component of Urban land is larger in areas adjacent to municipal, commercial, and transportation-corridor areas.

Typically, the surface layer of Haledon soils is dark grayish brown loam about 9 inches thick. The upper part of the subsoil is yellowish brown loam about 7 inches thick, underlain by yellowish brown, mottled silt

loam about 12 inches thick. The lower part of the subsoil is a fragipan of firm, reddish brown, mottled sandy loam about 16 inches thick. The substratum is dark yellowish brown, very firm gravelly loam to a depth of 60 inches.

The Urban land part of the unit is covered by streets, driveways, parking lots, buildings, and other impervious structures that obscure or alter the soils so that soil identification is not feasible.

Typically, the surface layer of Hasbrouck soils is very dark grayish brown silt loam about 10 inches thick, underlain by light brownish gray, mottled sandy loam about 6 inches thick. The upper part of the subsoil is light gray, mottled loam about 10 inches thick. The middle part of the subsoil is a gray, mottled clay loam about 4 inches thick. The lower part of the subsoil is a fragipan of firm light gray and reddish brown loam about 22 inches thick. The underlying substratum is firm, red, mottled loam to a depth of 60 inches.

Included with this unit in mapping are Boonton, Amwell, Raritan, Passaic, and Dunellen soils and Udorthents, loamy. The Raritan, Dunellen, and Passaic soils are mainly where glacial till borders outwash. The Boonton soils are on convex slopes of more than 8 percent. The Amwell soils are near the Watchung Mountains. The Udorthents are in areas of cuts and fills. Included soils make up about 10 percent of this map unit.

The permeability of this Haledon soil is moderate above the fragipan, but is slow in the fragipan. A perched water table is at a depth of 6 to 18 inches from winter through late spring. Available water capacity is moderate. Runoff is slow, and the hazard of erosion is moderate. Reaction is very strongly acid.

The permeability of this Hasbrouck soil is moderately slow above the fragipan and very slow in the fragipan. A perched water table is between the surface and a depth of 6 inches from fall through early summer. Available water capacity is high. Runoff is ponded, and the hazard of erosion is slight. Flooding is rare near streams and drainageways. Reaction is very strongly acid.

This unit is in extensively developed areas that are used for residential, commercial, and industrial purposes. The open portions of this unit are used for lawns, gardens, and small parks (fig. 3).

The perched water above the fragipan, ponding of

Figure 3.—Urban gardening in a small open area of Haledon-Urban land-Hasbrouck complex, 0 to 8 percent slopes.

surface water, and rare flooding are severe limitations of this unit for urban use. Drainage measures are needed to protect against damage to structures. Selection of the best method requires onsite investigation. Wetness-tolerant, perennial plants are suitable for landscaping.

Capability subclass: not assigned.

Hydrologic group: C/D (Haledon/Hasbrouck parts)

HctA—Hasbrouck silt loam, 0 to 3 percent slopes

This soil is nearly level and poorly drained. It is in depressions and level areas within undulating glacial till areas.

Typically, the surface layer of Hasbrouck soils is very dark grayish brown silt loam about 10 inches thick, underlain by light brownish gray, mottled sandy loam about 6 inches thick. The upper part of the subsoil is light gray, mottled loam about 10 inches thick. The middle part of the subsoil is a gray, mottled clay loam about 4 inches thick. The lower part of the subsoil is a fragipan of firm, light gray and reddish brown loam about 22 inches thick. The substratum is firm, red, mottled loam to a depth of 60 inches.

Included with this soil in mapping are Haledon, Parsippany, and Passaic soils, and Fluvaquents, frequently flooded. The Haledon soils are on slopes of more than 3 percent. The Fluvaquents are in recent alluvium, adjacent to streams. Most of the Passaic soils are near Ashbrook Reservation and other outwash areas. The Parsippany soils are near the eastern part of the county. Included soils make up about 15 percent of this map unit.

The permeability of this Hasbrouck soil is moderately slow above the fragipan and very slow in the fragipan. A perched water table is between the surface and a depth of 6 inches from fall through early summer. Excess water is perched on the fragipan. Available water capacity is high. Runoff is ponded, and the hazard of erosion is slight. Root penetration is restricted by the fragipan. Flooding is rare near streams and drainageways. Reaction is very strongly acid.

Most areas of this soil are woodland. The common trees are red maple, sweet gum, pin oak, and yellow poplar. Rooting depth is restricted by the fragipan. Windthrow hazard and the high water table are limitations for woodland.

This soil is severely limited for urban use by the slow permeability in the fragipan, the perched water table, frost-action potential, and the flooding and ponding hazards.

This unit is severely limited for lawns and landscaping by wetness due to the perched water table and runoff from surrounding higher areas. Drainage design should consider the existence of a fragipan. Suitable outlets for drainage are limited in many areas. Landscaping is limited to using plants that are tolerant of wetness and restricted rooting depth.

Capability subclass: IIIw

Hydrologic group: D

NehBc—Neshaminy silt loam, 0 to 8 percent slopes, extremely stony

This soil is gently sloping and well drained. It is on ridgetops of the Watchung Mountains.

Typically, the surface is extremely stony. The surface layer is a dark brown silt loam about 5 inches thick. The upper part of the subsoil is a reddish brown cobbly silt loam about 9 inches thick. The middle part is yellowish red gravelly clay loam about 14 inches thick. The lower part of the subsoil is brown cobbly clay loam about 14 inches thick. The substratum, to a depth of 60 inches, is reddish brown cobbly and gravelly silt loam.

Included with this soil in mapping are soils similar to this Neshaminy soil, but are 20 to 40 inches deep to bedrock, and areas of Neshaminy, Amwell, and Boonton soils that are less stony. The soils that are 20 to 40 inches to bedrock are on ridgetops of the Watchung Mountains. The less stony areas are throughout most units. The Amwell soils are on side slopes of the Watchung Mountains. The Boonton soils are in units in the eastern portion of the Watchung Reservation where the terminal moraine crosses the Watchung Mountains. Included soils make up about 20 percent of this map unit.

The permeability of this Neshaminy soil is moderately slow. Available water capacity is high. Runoff is slow, and the hazard of erosion is moderate. Reaction is very strongly acid to moderately acid.

Most areas of this soil are woodland. The common trees are northern red oak and yellow poplar.

This soil is generally suitable for residential development because it has good surface drainage. The surface stones are the main limitation.

This soil is severely limited for lawns and landscaping because of surface stoniness.

Capability subclass: VIs

Hydrologic group: B

NehCc—Neshaminy silt loam, 8 to 15 percent slopes, extremely stony

This soil is moderately sloping and well drained. It is on ridgetops and side slopes of the Watchung Mountains.

Typically, the surface is extremely stony. The surface layer is a dark brown silt loam about 5 inches thick. The upper part of the subsoil is reddish brown cobbly silt loam about 9 inches thick. The middle part is yellowish red gravelly clay loam about 14 inches thick. The lower part of the subsoil is brown cobbly clay loam about 14 inches thick. The substratum is reddish brown cobbly and gravelly silt loam to a depth of 60 inches.

Included with this soil in mapping are soils similar to this Neshaminy soil, but are 20 to 40 inches deep to bedrock. Also included are Amwell soils, bedrock outcrops, and rubble land. The soils that are 20 to 40 inches to bedrock and the bedrock outcrops are on ridgetops of the Watchung Mountains and on the side slopes. The Amwell soils are on the back slope of the First Watchung Mountain and both slopes of the Second Watchung Mountain. The rubble land is at the base of very steep slopes and near areas of bedrock outcrop. Included soils make up about 20 percent of this map unit.

The permeability of this Neshaminy soil is moderately slow. Available water capacity is high. Runoff is rapid, and the hazard of erosion is severe. Reaction is very strongly acid to moderately acid.

Most areas of this soil are woodland. The common trees are northern red oak and yellow poplar.

This sloping soil is generally suitable for residential development. The surface stones are the main limitation.

This unit is severely limited for lawns and landscaping by surface stoniness.

Capability subclass: VIIs

Hydrologic group: B

NehDc—Neshaminy silt loam, 15 to 25 percent slopes, extremely stony

This soil is steep and well drained. It is on side slopes and ridgetops of the Watchung Mountains.

Typically, the surface is extremely stony. The surface layer is a dark brown silt loam about 5 inches thick. The upper part of the subsoil is reddish brown cobbly silt loam about 9 inches thick. The middle part is yellowish red gravelly clay loam about 14 inches thick. The lower part of the subsoil is brown cobbly clay loam about 14 inches thick. The substratum is reddish brown cobbly and gravelly silt loam to a depth of 60 inches.

Included with this soil in mapping are soils similar to this Neshaminy soil, but that are 20 to 40 inches deep to bedrock, less stony Neshaminy soils, areas of bedrock outcrops and rubble land, and areas with steeper slopes. All of these inclusions are throughout the unit. Included soils make up about 20 percent of this map unit.

The permeability of this Neshaminy soil is moderately slow. Available water capacity is high. Runoff is rapid, and the hazard of erosion is severe. Reaction is very strongly acid to moderately acid.

Most areas of this soil are woodland. The common trees are northern red oaks and yellow poplar. The slope limits use of equipment.

Limitations for community development are severe because of slope and stoniness. Practices to control runoff, erosion, and sedimentation are needed during development.

This unit is severely limited for lawns and landscaping by surface stoniness.

Capability subclass: VIIs

Hydrologic group: B

NehFc—Neshaminy silt loam, 25 to 45 percent slopes, extremely stony

This soil is steep and well drained. It is on side slopes of the Watchung Mountains.

Typically, the surface is extremely stony. The surface layer is a dark brown silt loam about 5 inches thick. The upper part of the subsoil is reddish brown cobbly silt loam about 9 inches thick. The middle part is yellowish red gravelly clay loam about 14 inches thick. The lower part of the subsoil is brown cobbly clay loam about 14 inches thick. The substratum is reddish brown cobbly and gravelly silt loam to a depth of 60 inches.

Included with this soil in mapping are soils similar to this Neshaminy soil, but are 20 to 40 inches to bedrock, less stony Neshaminy soils, areas of bedrock outcrops and rubble land, areas with steeper slopes, and areas that are less steep. All of these inclusions are throughout the unit. Included soils make up about 20 percent of this map unit.

The permeability of this Neshaminy soil is moderately slow. Available water capacity is high. Runoff is rapid, and the hazard of erosion is severe. Reaction is very strongly acid to moderately acid.

Most areas of this soil are woodland. The common trees are northern red oak and yellow poplar. The slope limits the use of equipment.

Limitations for community development are severe because of slope and stoniness. Practices to control runoff, erosion, and sedimentation are needed during development.

This soil is not suited for lawn and landscape development because of surface stoniness and steep slopes.

Capability subclass: VIIs

Hydrologic group: B

NenB—Neshaminy-Urban land complex, 0 to 8 percent slopes

This unit consists mostly of well drained Neshaminy soils and areas of Urban land. Slopes are dominantly 0 to 8 percent, but range to 15 percent in some areas. The areas of this unit contain 55 percent Neshaminy soils, 20 percent Urban land, and 25 percent other soils.

Typically, the surface of Neshaminy soils is extremely stony. The surface layer is dark brown silt loam about 5 inches thick. The upper part of the subsoil is reddish brown cobbly silt loam about 9 inches thick. The middle part is yellowish red gravelly clay loam about 14 inches thick. The lower part of the subsoil is brown cobbly clay loam about 14 inches thick. The substratum is reddish brown cobbly and gravelly silt loam to a depth of 60 inches.

The Urban land portion of the unit is covered by streets, driveways, buildings, and other impervious structures that obscure or alter the soils so that soil identification is not feasible.

Included with this unit in mapping are Amwell and Boonton soils and Udorthents, loamy. The Amwell soils are near the base of the back slope of the First Watchung Mountain and both slopes of the Second Watchung Mountain. The Boonton soils are where the terminal moraine crosses the Watchung Mountains. The Udorthents are in areas of cuts and fills. Bedrock is exposed in some excavated areas. Included soils make up about 25 percent of this map unit.

This unit is in extensively developed, residential areas. The open portion of this unit is used for lawns and wooded areas.

This unit has moderate limitations for building sites and other engineering uses because of the proximity of basalt bedrock. This unit has a severe limitation for lawns because of the stones on the surface.

Capability subclass: not assigned.

Hydrologic group: B (Neshaminy part)

NenD—Neshaminy-Urban land complex, 15 to 25 percent slopes

This unit consists mostly of well drained Neshaminy soils and Urban land. Slopes are 15 to 25 percent. The areas of this unit contain 40 percent Neshaminy soils, 20 percent Urban land, and 40 percent other soils.

Typically, the surface of the Neshaminy soils is extremely stony. The surface layer is dark brown silt loam about 5 inches thick. The upper part of the subsoil is reddish brown, cobbly silt loam about 9 inches thick. The middle part is yellowish red, gravelly clay loam about 14 inches thick. The lower part of the subsoil is brown, cobbly clay loam about 14 inches thick. The substratum is reddish brown, cobbly silt loam to a depth of 60 inches.

The Urban land portion of the unit is covered by streets, driveways, buildings, and other impervious structures that obscure or alter the soils so that soil identification is not feasible.

Included with this unit in mapping are Dunellen, Boonton, and Amwell soils, bedrock outcrops, Udorthents, loamy, and moderately well drained soils that have a contrasting stratified gravelly and sandy substratum. The bedrock outcrops and rubble land, the Dunellen, Boonton, and Amwell soils, and the moderately well drained soils are in New Providence and Berkeley Heights. The Boonton soils are where the terminal moraine crosses the Watchung Mountains in Mountainside and Summit. The Udorthents are in areas of cuts and fills. The bedrock outcrops and rubble land are near the ridgetops and at the base of steep slopes. Included soils make up about 40 percent of this map unit.

This unit is in extremely developed, residential areas. The open portion of this unit is used for lawns.

This unit has severe limitations for urban use because of slopes, stoniness, and proximity to basalt bedrock. This unit is not suited for lawns and landscaping because of surface stoniness and steep slopes.

Capability subclass: not assigned.

Hydrologic group: B (Neshaminy part)

Pbp—Parsippany silt loam

This soil is nearly level and poorly drained. It is on low flats and in slight depressions in the area of old glacial Lake Passaic.

Typically, the surface layer is dark gray silt loam about 3 inches thick, underlain by gray, mottled silt loam about 5 inches thick. The upper part of the subsoil is light gray, mottled silty clay loam about 10 inches thick. The lower part of the subsoil is reddish brown, mottled silty clay about 27 inches thick. The substratum is reddish brown, mottled silty clay loam to a depth of 60 inches.

Included with this soil in mapping are Whippany and

Amwell soils, Fluvaquents, frequently flooded, and Passaic soils. Passaic and Whippany soils are the most extensive inclusions. The Passaic soils are in small areas throughout most units but mostly near New Providence and Summit. The Whippany soils are on low knolls or around the edges of low knolls. The Amwell soils are mostly at the margins of units where the Parsippany soils grade into surrounding uplands. The Fluvaquents are adjacent to streams. Included soils make up about 20 percent of this map unit.

The permeability of this Parsippany soil is slow. Available water capacity is high. Runoff is ponded, and the hazard of erosion is slight. A water table is between the surface and a depth of 12 inches from fall through early summer. Because of its low position on the landscape, the soil receives runoff from adjoining areas. Because of the high content of silt and clay, the soil has poor workability, low stability, and poor compaction characteristics, especially when wet. Areas adjacent to drainageways are subject to occasional flooding. Reaction is very strongly acid in the surface layer and slightly acid in the subsoil.

Most areas of this soil are woodland. The common tree is red maple and smaller amounts of sweet gum, pin oak, and swamp oak. The common shrubs are spice bush, alder, and red-osier dogwood. Equipment limitations, seedling mortality, plant competition, and windthrow due to shallow rooting, are the main concerns.

This soil is severely limited for urban use by wetness, flooding in places, slow permeability, and frost-action potential.

Capability subclass: Vw
Hydrologic group: C/D

Pbs—Parsippany-Urban land complex, 0 to 3 percent slopes

This unit consists mostly of poorly drained Parsippany soils and areas of Urban land. Slopes are 0 to 3 percent. The areas of this unit contain 45 percent Parsippany soils, 30 percent Urban land, and 25 percent other soils.

Typically, the surface layer of Parsippany soils is dark gray silt loam about 3 inches thick, underlain by a gray, mottled silt loam about 5 inches thick. The upper part of the subsoil is light gray, mottled silty clay loam about 10 inches thick. The lower part of the subsoil is reddish brown, mottled silty clay about 27 inches. The substratum is reddish brown, mottled silty clay loam to a depth of 60 inches.

The Urban land part of the unit is covered by streets, driveways, parking lots, buildings, and other impervious structures that obscure or alter the soils so that soil identification is not feasible.

Included with this unit in mapping are Hasbrouck and Passaic soils. The Hasbrouck soils are in glaciated parts of the county. The Passaic soils are common in outwash areas. Both Hasbrouck and Passaic soils have properties and use and management that are similar to those of the Parsippany soils. Other minor inclusions are Haledon, Carlisle, Adrian, and Raritan soils, Udorthents, loamy, and Fluvaquents, frequently flooded. The Haledon and Raritan soils are at edges of the unit near better drained soils. The Carlisle and Adrian soils are in small depressional areas. The Udorthents are in cut and fill areas. The Fluvaquents are adjacent to streams. Included soils make up about 25 percent of this map unit.

The permeability of this Parsippany soil is slow. Available water capacity is high. Runoff is ponded, and the hazard of erosion is slight. A water table is between the surface and a depth of 12 inches from fall through early summer. Because of its low position on the landscape, the soil receives runoff from adjoining areas. Because of the high content of silt and clay, the soil has poor workability, low stability, and poor compaction characteristics, especially when wet. Areas of Parsippany soils adjacent to drainageways, are subject to occasional flooding. Reaction is very strongly acid in the surface layer and slightly acid in the subsoil.

This unit is in extensively developed areas that are used for residential, commercial, or industrial purposes. The open portions of this unit are used for lawns, vacant wooded lots, gardens, and small parks.

Landscaping is limited to using plants that are tolerant of wetness.

Capability subclass: not assigned.
Hydrologic group: C/D (Parsippany part)

Pcs—Passaic silt loam

This soil is nearly level and poorly drained. It is formed in stratified sediment of lacustrine origin, derived mainly from sandstone, shale, and basalt.

Typically, the surface layer is black silt loam about 4 inches thick, underlain by dark gray silt loam about 6 inches thick. The upper part of the subsoil is light gray, mottled silty clay loam about 6 inches thick. The middle part is light gray, mottled silty clay about 8 inches thick. The lower part of the subsoil is light gray, mottled clay loam about 4 inches thick. The substratum is reddish brown, gravelly loamy sand to a depth of 60 inches.

Included with this soil in mapping are Adrian muck,

Fluvaquents, frequently flooded, and Hasbrouck, Raritan, and Whippany soils. The most common inclusions, Adrian muck and Fluvaquents, are mainly along streams. The Hasbrouck soils are in depressions in lowlands behind the terminal moraine. The Raritan and Whippany soils are mainly adjacent to better drained areas. Included soils make up about 20 percent of this map unit.

The permeability of this Passaic soil is slow in the surface layer and subsoil and rapid in the substratum. A water table is between the surface and a depth of 12 inches from fall through spring. Available water capacity is high. Runoff is ponded, and the hazard of erosion is slight. In most places the soils flood annually. Reaction is very strongly acid to neutral in the surface layer and subsoil, and neutral or alkaline in the substratum.

Most areas of this soil are in parks and open space.

The common trees are red maple, sweetgum, and pin oak. This soil has poor potential productivity as commercial woodland. The main limitations are poor trafficability and windthrow hazard.

The high water table, slow permeability, and the potential of flooding, severely limits this soil for urban use.

This unit is severely limited for lawns and landscaping by wetness. Landscaping is limited to using plants that are tolerant of wetness and restricted rooting depth.

Capability subclass: Vw

Hydrologic group: D

RarA—Raritan silt loam, 0 to 3 percent slopes

This soil is nearly level and somewhat poorly drained. It is on low stream terraces and in areas where glacial till grades into outwash or lacustrine areas.

Typically, the surface layer is dark brown silt loam about 8 inches thick, underlain by brown loam about 4 inches thick. The upper part of the subsoil is brown, mottled loam about 10 inches thick. The middle part is light gray, mottled clay loam about 6 inches thick. The lower part of the subsoil is light gray, mottled loam about 8 inches thick. The substratum is a reddish brown, mottled loamy sand, to a depth of 60 inches. In some areas, the surface layer is fine sandy loam.

Included with this soil in mapping are Haledon and Passaic soils, Fluvaquents, frequently flooded, and moderately well drained soils with a contrasting stratified gravelly and sandy substratum. The Haledon soils are where outwash is adjacent to Haledon and Boonton soils. The moderately well drained soils are mainly adjacent to Dunellen soils. The Passaic soils and the Fluvaquents are adjacent to drainageways, and broad, nearly level lowlands. Included soils make up about 20 percent of this unit.

The permeability of this Raritan soil is moderately slow in the lower part of the subsoil and rapid in the substratum. A perched water table is at a depth of 6 to 36 inches from fall through early spring. Available water capacity is moderate. Runoff is slow, and the hazard of erosion is slight. Rare flooding occurs in areas adjacent to streams. Reaction is slightly acid to moderately acid.

Most areas of this soil are wooded or in abandoned fields. A few small areas are used for crops. The common trees are sweetgum, red maple, and oak. The high water table and the flooding frequency adjacent to streams, are the main limitations for woodland use.

The soil has severe limitations for urban use because of the high water table, the flooding potential adjacent to streams, and the moderately slow permeability. The soil can be drained using tile. The slower permeability of the subsoil will perch water after heavy rains or flooding.

This unit is limited for lawns and landscaping by wetness due to the perched water table. The coarse textured substratum allows the use of tile drains to remove excess water. These drains, in combination with measures to alleviate the perched water above the moderately fine textured subsoil, are generally effective. Landscaping is limited to using plants that are tolerant of wetness.

Capability subclass: IIw

Hydrologic group: C

RasA—Raritan-Urban land-Passaic complex, 0 to 3 percent slopes

This unit consists mostly of somewhat poorly drained Raritan soils, areas of Urban land, and poorly drained Passaic soils. Slopes are 0 to 3 percent. The areas of this unit contain 45 percent Raritan soils, 25 percent Urban land, 20 percent Passaic soils, and 10 percent other soils.

Typically, the surface layer of Raritan soils is dark brown silt loam about 8 inches thick, underlain by brown loam about 4 inches thick. The upper part of the subsoil is brown, mottled loam about 10 inches thick. The middle part is light gray, mottled clay loam about 6 inches thick. The lower part of the subsoil is light gray, mottled loam about 8 inches thick. The substratum is a reddish brown, mottled loamy sand, to a depth of 60 inches. In some areas the surface layer is fine sandy loam.

The Urban land part of the unit is covered by streets, driveways, parking lots, buildings, and other impervious structures that obscure or alter the soils so that identification is not feasible.

Typically, the surface layer of Passaic soils is black silt loam about 4 inches thick, underlain by dark gray silt loam about 6 inches thick. The upper part of the subsoil is light gray, mottled silty clay loam about 6 inches thick. The middle part is light gray, mottled silty clay about 8 inches thick. The lower part of the subsoil is light gray, mottled clay loam about 4 inches thick. The substratum is reddish brown gravelly loamy sand to a depth of 60 inches.

Included with this unit in mapping are Haledon soils, Fluvaquents, frequently flooded, moderately well drained soils with a contrasting stratified gravelly and sandy substratum, and Udorthents, loamy. The Haledon soils are where glacial till grades into outwash areas. The Udorthents are in fill areas. The moderately well drained soils are throughout the unit. The Fluvaquents are in depressional areas adjacent to streams. Included soils make up about 10 percent of this unit.

The permeability of this Raritan soil is moderately slow in the lower part of the subsoil and rapid in the substratum. A perched water table is at a depth of 6 to 36 inches from fall through early spring. Available water capacity is moderate. Runoff is slow, and the hazard of erosion is slight. Rare flooding occurs in areas adjacent to streams. Reaction is slightly acid to moderately acid.

The permeability of this Passaic soil is slow in the surface layer and subsoil, and rapid in the substratum. A water table is between the surface and a depth of 12 inches from fall through spring. Available water capacity is high. Runoff is ponded, and the hazard of erosion is slight. In most places, the soils flood annually. Reaction is very strongly acid to neutral in the surface layer and subsoil, and neutral or alkaline in the substratum.

This unit is in extensively developed areas that are used for residential, commercial, and industrial purposes. The open portions of this unit are used for lawns, vacant wooded lots, gardens, and small parks.

This unit is severely limited for urban use by slow permeability of the subsoil, flooding potential, rapid permeability of the substratum, which causes a hazard of ground-water pollution, and wetness. Tile drainage systems need to be installed to remove excess water. The perched water table above the subsoil limits site preparation. Building sites often require filling in addition to drainage.

Capability subclass: not assigned.

Hydrologic group: C/D (Raritan and Passaic parts)

SUCT—Sulfihemists and Sulfaquents, frequently flooded

This unit consists of level, very poorly drained soils in marine and estuarine marshes that are subject to daily tidal flooding. The areas are remnants of tidal marsh areas along the Arthur Kill and its tributaries. Slopes are 0 to 1 percent. These soils are mapped together because they have no significant differences in use and management.

Typically, the surface layer of Sulfihemists is dark brown fibric organic material about 4 inches thick, underlain by yellowish brown fibric organic material to a depth of 18 inches. Under that are very dark grayish brown partially decomposed organic material and silty or sandy mineral layers to a depth of 60 inches.

Typically, the surface layer of Sulfaquents is a black muck about 10 inches thick, underlain by dark gray organic silt and a thin strata of organic material to a depth of 36 inches. The substratum is gray sand to a depth of 60 inches.

Included with these soils in mapping are poorly drained mineral soils, Parsippany soils, and areas of shallow organic soils over silty soils. Also included are areas of Udorthents, organic substratum. Included soils make up about 15 percent of this map unit.

The native vegetation consists of salt-tolerant grasses and shrubs.

Continuous saturation, low bearing capacity, sulfidic soil, and the daily flooding by brackish tidal water, are limitations of these soils.

This unit is not suited for lawns and landscaping because of wetness, tidal flooding, excess humus, unsuitability to trees, and corrosion hazard to iron and concrete.

The soils are suitable to wildlife habitat.

Capability subclass: not assigned.

Hydrologic group: D

TunE—Tunkhannock gravelly loam, 25 to 45 percent slopes

This soil is steep and well drained. It formed in water-sorted glacial deposits and is on kames and eskers.

Typically, the surface layer is dark reddish brown gravelly loam about 3 inches thick. The upper part of the subsoil is yellowish red, very cobbly loam about 17 inches thick. The lower part of the subsoil is reddish brown very cobbly sandy loam, about 8 inches thick. The substratum is reddish brown very cobbly loamy sand to a depth of 60 inches.

Included with this soil in mapping are Dunellen,

Boonton, and Birdsboro soils. The Birdsboro and Dunellen soils and some other inclusions are on slopes of less than 25 percent. The Boonton soils border uplands. Included soils make up about 15 percent of this map unit.

The permeability of this Tunkhannock soil is moderately rapid in the surface layer and subsoil, and rapid in the substratum. Available water capacity is low. Runoff is very rapid, and the hazard of erosion is severe. Reaction is extremely acid to strongly acid.

Most areas of this soil are woodland and open space. The common trees are northern red oak, sugar maple, and beech. Steep slopes and the hazard of erosion are major limitations for woodland use.

Steep slopes and the erosion hazard are major limitations for urban development. Rapid permeability in the substratum causes a hazard of ground-water pollution.

This unit is severely limited for lawns and landscaping by slope and gravel content. Maintaining a plant cover is difficult where the sandy substratum is exposed. This soil is droughty during extended dry periods.

Capability subclass: VIe
Hydrologic group: A

Ucd—Udifluvents, frequently flooded

This soil is moderately well drained and somewhat poorly drained and, in most areas, nearly level. This soil is mostly in areas in the Elizabeth River system. Before extensive development, the soil was poorly drained, loamy alluvium. Erosion and sedimentation from nearby coarse-textured areas have deposited sand and sandy loam over the loamy alluvium.

Included with this unit in mapping are Raritan, Adrian, and Carlisle soils, Fluvaquents, frequently flooded, moderately well drained soils with a contrasting stratified gravelly and sandy substratum, and Udorthents, loamy. The Raritan soils and the moderately well drained soils are at slightly higher positions near the edges of this unit. The Adrian and Carlisle soils and the Fluvaquents, are mainly in small depressional areas. The Udorthents are fill areas commonly at construction or building sites. Included soils make up about 20 percent of this map unit.

The permeability of these Udifluvents is moderate to rapid. Drainage is somewhat poorly drained to moderately well drained. A water table is at a depth of 6 to 48 inches throughout the year. Some filling of this flood plain soil has taken place. Dikes have been erected, further changing the drainage patterns.

Most areas of this unit are parks. The soils have not been extensively developed because of the hazard of flooding and the probability of severe flood damage.

Capability subclass: Vw
Hydrologic group: C

Udh—Udorthents, loamy

This unit consists of areas that have been cut or filled during grading and other site preparation work for residential development, roads, watershed projects, and recreation areas. Cuts make up the steep portions of the unit. Fill areas are generally nearly level or gently sloping.

Included with this unit in mapping are soils that have not been appreciably altered by cutting or filling, Urban land, sanitary landfills, and Udorthents over tidal marsh in the most eastern portion of the county. Included soils make up about 20 percent of this map unit.

This characteristics unit is so variable that onsite investigation is needed to determine the potentials and limitations for any proposed use.

Capability subclass: not assigned.

Udy—Udorthents, organic substratum

This unit consists of areas along the Arthur Kill where various types of material have been used to fill tidal marsh. Dredged material makes up a considerable portion of this unit.

Included with this unit in mapping are sanitary landfills, areas of undisturbed tidal marsh, Udorthents, loamy, and Urban land. Oil refineries, Newark Airport, and Port Authority facilities are in this map unit. Included soils make up about 20 percent of this map unit.

This unit is so variable that onsite investigation is needed to determine the potentials and limitations for any proposed use.

Capability subclass: not assigned.

Udz—Udorthents, refuse substratum

This unit consists of areas that have been used for disposing of refuse consisting of bricks, glass, cement, wood, wire, asphalt, plastic containers, cans, and objects. Many areas are municipally owned.

This unit has poor potential for building purposes. The refuse is variable and often generates gas, which is a hazard to building and recreational areas. This unit is subject to subsidence as organic materials decay. Therefore, if these areas are used for development, careful onsite investigation is needed.

Capability subclass: not assigned.

UR—Urban land

This unit is nearly level or gently sloping.

It is throughout the survey area, and the largest areas are adjacent to Routes 22 and 28 and in Elizabeth. The smaller areas are industrial parks and various downtown districts. More than 90 percent of the surface of the unit is covered by asphalt, concrete, buildings, and other impervious surfaces. Examples are parking lots, shopping and business centers, and industrial parks.

Included with this unit in mapping are Udorthents, loamy, and small areas of undisturbed soils. The undisturbed soils are commonly similar to soils in surrounding or nearby units. Included soils make up about 10 percent of this map unit.

Onsite investigation is needed to determine the potentials and limitations for any proposed use.

Capability subclass: not assigned.

WhpA—Whippany silt loam, 0 to 3 percent slopes

This soil is nearly level and somewhat poorly drained. It is derived from lacustrine sediments and is on low flats and in slight depressions in the old glacial Lake Passaic.

Typically, the surface layer is dark brown silt loam about 4 inches thick. The upper part of the subsoil is yellowish brown, mottled silt loam about 11 inches thick. The lower part of the subsoil is dark yellowish brown, mottled silty clay about 29 inches thick. The substratum is brown, mottled silty clay loam to a depth of 60 inches.

Included with this soil in mapping are Parsippany, Haledon, and Amwell soils, Aquents, frequently flooded, and moderately well drained soils with a more sandy subsoil. Parsippany soils are in depressions and along drainageways. Haledon and Amwell soils and the moderately well drained soils are mainly near the edges where this unit grades into nearby uplands. Aquents, frequently flooded, are adjacent to major streams. Included soils make up about 20 percent of this map unit.

The permeability of this Whippany soil is slow in the subsoil. Available water capacity is high. Runoff is slow, and the hazard of erosion is slight. A perched water table is at a depth of 6 to 18 inches from late fall through early spring. Because of the high clay and silt content, these soils have poor workability, low stability, and poor compaction characteristics, especially when wet. Flooding is rare. Reaction is very strongly acid in the surface layer and upper part of the subsoil, and ranges to slightly acid in the lower part of the subsoil.

Most undeveloped areas of this unit are woodland. The common trees are white and pin oaks, yellow poplar, and beech. The common shrubs are silky dogwood, spice bush, and elderberry. The major woodland concerns are equipment limitations, seedling mortality, and plant competition.

This soil is severely limited for many urban uses by wetness, ponding, slow permeability, frost-action potential, and flooding.

This unit is limited for lawns and landscaping by wetness and runoff from surrounding higher areas. The clayey subsoil precludes the use of tile drains. Open ditches generally are more effective, but suitable outlets may not be available. Landscaping is limited to using plants that are tolerant of wetness.

Capability subclass: IIIw

Hydrologic group: C

WhpB—Whippany silt loam, 3 to 8 percent slopes

This soil is gently sloping and somewhat poorly drained. It formed from lacustrine sediments in old glacial Lake Passaic.

Typically, the surface layer is dark brown silt loam about 4 inches thick. The upper part of the subsoil is yellowish brown, mottled silt loam about 11 inches thick. The lower part of the subsoil is dark yellowish brown, mottled silty clay about 29 inches thick. The substratum is brown, mottled silty clay loam to a depth of 60 inches.

Included with this soil in mapping are Amwell and Haledon soils and moderately well drained soils with a more sandy subsoil. Most of these soils are near the edges of this unit. Some are scattered on isolated small mounds. Included soils make up about 20 percent of this map unit.

The permeability of this Whippany soil is slow in the subsoil. Available water capacity is high. Runoff is slow, and the hazard of erosion is moderate. A perched water table is at a depth of 6 to 18 inches from late fall through early spring. Because of the high clay and silt content, these soils have poor workability, low stability, and poor compaction characteristics, especially when wet. Flooding is rare. Reaction is very strongly acid in the surface layer and upper part of the subsoil, and ranges to slightly acid in the lower part of the subsoil.

Most undeveloped areas of this unit are woodland. The common trees are red oak, white and pin oaks, yellow poplar, and beech. The common shrubs are

silky dogwood, spice bush, and elderberry. The major woodland concerns are equipment limitations, seedling mortality, and plant competition.

This soil is severely limited for urban use by wetness, slow permeability, and frost-action potential.

This soil is limited for lawns and landscaping by wetness. Slope limits application of effective drainage measures. Landscaping is limited to using plants that are tolerant of wetness and restricted rooting depth.

Capability subclass: IIIw

Hydrologic group: C

WhrB—Whippany-Urban land complex, 0 to 8 percent slopes

This unit consists mostly of somewhat poorly drained Whippany soils and areas of Urban land. The Whippany soils are on nearly level areas and gentle slopes. Areas of Urban land are throughout the unit; many are small residential areas, and a few are large areas adjacent to industrial buildings. Slopes are 0 to 8 percent. The areas of this unit contain 50 percent Whippany soils, 30 percent Urban land, and 20 percent other soils.

Typically, the surface layer of the Whippany soil is dark brown silt loam about 4 inches thick. The upper part of the subsoil is yellowish brown, mottled silt loam about 11 inches thick. The lower part of the subsoil is dark yellowish brown, mottled silty clay about 29 inches thick. The substratum is brown, mottled silty clay loam to a depth of 60 inches.

The Urban land part of the unit is generally fill covered by streets, driveways, parking lots, buildings, and other impervious structures that obscure or alter the soils so that soil identification is not feasible.

Included with this unit in mapping are Parsippany, Amwell, and Haledon soils, Fluvaquents, frequently flooded, Udorthents, loamy, and moderately well drained soils with a more sandy subsoil. The Parsippany soils and Fluvaquents, frequently flooded, are in low positions adjacent to streams. The Amwell and Haledon soils and the moderately well drained soils are mainly near edges where this unit grades into nearby upland soils. Udorthents, loamy, are in areas of fill. Included soils make up about 20 percent of this map unit.

The permeability of this Whippany soil is slow in the subsoil. Available water capacity is high. Runoff is slow and sometimes ponded, and the hazard of erosion is slight. A perched water table is at a depth of 6 to 18 inches from late fall through early spring. Because of the high clay and silt content, these soils have poor workability, low stability, and poor compaction characteristics, especially when wet. Flooding is rare. Reaction is very strongly acid in the surface layer and upper part of the subsoil and ranges to slightly acid in the lower part of the subsoil.

This unit is in extensively developed areas that are used for residential, commercial, or industrial purposes. The open portions of this unit are used for lawns, vacant wooded lots, gardens, and small parks.

This unit is not suited to urban development. Drainage measures are limited by the slow permeability. The low landscape position provides few outlets for removal of excess water. Landscaping is limited to using plants that are tolerant of wetness. Building sites often require filling in addition to drainage.

Capability subclass: not assigned.

Hydrologic group: C (Whippany part)

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is available for these uses. It could be cultivated land, pastureland, forest land, or other land, but it is not urban or built-up land or water areas. The soil qualities, growing season, and moisture supply are those needed for the soil to economically produce sustained high yields of crops when proper management, including water management, and acceptable farming methods are applied. In general, prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, an acceptable salt and sodium content, and few or no rocks. It is permeable to water and air. It is not excessively erodible or saturated with water for long periods, and it either is not frequently flooded during the growing season or is protected from flooding. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Natural Resources Conservation Service.

About 3,815 acres in the survey area, or nearly 6 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, west of US Route 1.

A recent trend in land use in some parts of the survey area has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. On some soils included in the list, measures that overcome a hazard or limitation, such as flooding, wetness, and droughtiness, are needed. Onsite evaluation is needed to determine whether or not the hazard or limitation has been overcome by corrective measures. The extent of each listed map unit is shown in table 5. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Over 1,949 acres of the prime farmland consists of well drained and moderately well drained soils on ridgetops and benches on uplands. Nearly 1,900 acres consists of somewhat poorly drained soils.

The map units that meet the requirements for prime farmland are:

BhnB	Birdsboro silt loam, 3 to 8 percent slopes
BogB	Boonton loam, 3 to 8 percent slopes
DunB	Dunellen sandy loam, 3 to 8 percent slopes
HakA	Haledon loam, 0 to 3 percent slopes
HakB	Haledon loam, 3 to 8 percent slopes
RarA	Raritan silt loam, 0 to 3 percent slopes
WhpA	Whippany silt loam, 0 to 3 percent slopes
WhrB	Whippany silt loam, 3 to 8 percent slopes

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops (9). Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive land forming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion

unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-6.

The capability classification of each map unit is given in the section "Detailed Soil Map Units".

Woodland Management and Productivity

Table 6 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; and *F*, a high content of rock fragments in the soil. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, and F.

In table 6, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, fire lanes, and log-handling areas. Forests that have been burned or overgrazed are also subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

The proper construction and maintenance of roads, trails, landing, and fire lanes will help overcome the erosion hazard (fig. 4).

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment or season of use is not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 2 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 2 to 6 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 6 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are

important. Replanting may be necessary. Expected mortality is more than 50 percent.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced on a fully stocked, even-aged, unmanaged stand.

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the dominant species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Figure 4.—The culvert protects a dirt road in the map unit of Amwell silt loam, 3 to 8 percent slopes.

Recreation

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 7, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 8, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat *(1)*.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for

satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are mountainmahogany, bitterbrush, snowberry, and big sagebrush.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, deer, and bear.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver (fig. 5).

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified (*11*). The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Figure 5. —This small recreation pond, built in a unit of Raritan-Urban land-Passaic complex, 0 to 3 percent slopes, provides sites for fishing as well as habitat for waterfowl.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 10 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills *(11)*. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that

part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After the soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair, or poor* as a source of roadfill and topsoil *(11)*. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place.

In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed excavated ponds *(11)*. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome;

Figure 6.—A small stream is contained in a well-established grassed waterway in a map unit of Haledon loam, 3 to 8 percent slopes.

moderate if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan.

The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity (fig. 6). Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in the tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed (*8*). During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 13.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features are also given.

Engineering Index Properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture (*8*). These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*3*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*2*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 9.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated

sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2

millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 10, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 15 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to two hydrologic groups in table 15, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in

the soil. Indicated in table 15 are the depth to the seasonal high water table; the kind of water that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 15.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Subsidence is the settlement of organic soils or of saturated mineral soils of very low density. Subsidence results from either desiccation and shrinkage or oxidation of organic material, or both, following drainage. Subsidence takes place gradually, usually over a period of several years. Table 11 shows the expected initial subsidence, which usually is a result of drainage, and total subsidence, which usually is a result of oxidation.

Not shown in the table is subsidence caused by an imposed surface load or by the withdrawal of ground water throughout an extensive area as a result of lowering the water table.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*8*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series.

Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 16 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol.* An example is Entisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquent (*Aqu*, meaning water, plus *ent*, from Entisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquents (*Hapl*, meaning minimal horizonation, plus *aquent*, the suborder of the Entisols that has an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquents.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, nonacid, mesic Typic Haplaquents.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*8*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*10*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Adrian Series

The soils of the Adrian series are sandy or sandy-skeletal, mixed, euic, mesic Terric Medisaprists. They are very deep and very poorly drained, organic soils that are 16 to 50 inches deep over sandy material. They formed in low areas that were formerly lakes, ponds, and flood plains. Over a period of thousands of

years, these lakes and ponds have been filling by the accumulation of organic material and mineral sediments. Slopes are 0 to 2 percent.

Typical pedon of Adrian muck in an area of Carlisle-Adrian mucks in Ashbrook Swamp, approximately 1,000 feet south of Martine Avenue extension, 1/3 mile east of the intersection of Martine Avenue and Raritan Road in Scotch Plains:

Oa1—0 to 6 inches; black (N 2/0) muck (sapric material); moderate medium granular structure; many fine roots; moderately acid; gradual smooth boundary.

Oa2—6 to 24 inches; black (N 2/0) muck (sapric material); moderate medium granular structure; many fine and medium roots; about 10 percent fibrous composed of decomposing leaves and roots; neutral; abrupt smooth boundary.

C1—24 to 32 inches; light brownish gray (10YR 6/2) and dark gray (10YR 4/1) sand; moderate medium and coarse granular structure; friable; dark brown (7.5YR 4/2) sapric material; slightly acid; clear smooth boundary.

C2—32 to 48 inches; reddish brown (5YR 5/4) and strong brown (7.5YR 5/8) loamy fine sand; many medium prominent yellowish red (5YR 5/8) mottles; strong coarse platy structure; very friable; common distinct clay films lining interstitial pores; neutral; clear smooth boundary.

C3—48 to 58 inches; reddish brown (5YR 5/4) very fine sandy loam; many medium prominent yellowish red (5YR 5/8) mottles; strong coarse platy structure; very friable; slightly acid; clear smooth boundary.

C4—58 to 60 inches; reddish brown (5YR 5/4) very fine sand; single grain; loose; slightly acid.

Depth to the underlying sandy C horizon ranges from 16 to 50 inches. Reaction is moderately acid to neutral.

The Oa horizon has hue of 7.5YR, 10YR, or neutral, value of 2, and chroma of 0 to 2. The organic material is dominantly sapric, but in places there are thin layers of hemic and fibrous material.

The C horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 1 to 8. The horizon is stratified with material ranging from sand to very fine sandy loam. Reaction is moderately acid to neutral.

Amwell Series

The soils of the Amwell series are fine-loamy, mixed, mesic Aquic Fragiudalfs. They are very deep, moderately well drained and somewhat poorly drained soils. They formed from colluvium associated with the First and Second Watchung Mountains. The soil materials are either colluvium with a large content of basalt or are older deposits of moraine drift underlain by material weathered from red shale or basalt bedrock. Slopes are 3 to 15 percent.

Typical pedon of Amwell silt loam, 3 to 8 percent slopes, 1,000 feet northwest along bridle trail, north of the traffic circle intersection of Park Drive and Summit Lane in the Watchung Reservation:

Oa—1/2 inch to 0; black (N 2/0) well decomposed organic matter; common fine and medium roots; extremely acid; abrupt smooth boundary.

A—0 to 5 inches; dark brown (7.5YR 4/2) silt loam; weak medium granular structure; very friable; common fine and medium roots; moderately acid; clear smooth boundary.

Bt—5 to 18 inches; dark brown (7.5YR 4/4) silt loam; few coarse distinct light brownish gray (2.5Y 6/2) and few faint yellowish red (5YR 4/6) mottles; moderate medium angular blocky structure; friable; few medium and coarse roots; common distinct clay films lining interstitial pores; moderately acid; clear wavy boundary.

Btx—18 to 32 inches; brown (7.5YR 5/4) silt loam; many coarse distinct yellowish red (5YR 4/6) and few coarse distinct light brown (7.5YR 6/4) mottles; weak coarse prismatic structure parting to thick platy; firm; many prominent clay films on faces of peds; common black stains; few fine rounded quartz gravel; moderately acid; gradual wavy boundary.

C—32 to 60 inches; reddish brown (2.5YR 4/4) silty clay loam; common coarse distinct light reddish brown (5YR 6/3) mottles; weak platy structure; firm; about 5 percent fine rounded quartz and red shale gravel; few basalt cobbles; moderately acid.

The solum thickness is 30 to 50 inches. The depth to shale or basalt bedrock is 4 feet or more. Rock fragments make up as much as 20 percent of the upper part the solum and 5 to 50 percent of the lower part. The rock fragments are angular to rounded cobbles and gravel of basalt, quartz, shale, sandstone, and gneiss. Few boulders are on the surface of some areas. On moderately steep slopes, basalt stones cover 1 to 3 percent of the surface. Reaction ranges from slightly acid to moderately acid.

The A horizon has hue of 7.5YR or 10YR and value of 2 to 4, and chroma of 2 to 4. Texture is dominantly silt loam.

The Bt and Bx horizons have hue of 5YR to 10YR, value of 4 to 7, and chroma of 2 to 8. Texture is silt loam or silty clay loam or their gravelly analogs. The

Bx horizon generally has more rock fragments and black staining than the Bt horizon.

The C horizon has hue of 2.5YR to 10YR and value of 4 to 6, and chroma of 1 to 7. Texture is silt loam, loam, silty clay loam, or their gravelly or cobbly analogs.

Birdsboro Series

The soils of the Birdsboro series are fine-loamy, mixed, mesic Typic Hapludults. They are very deep, well drained soils. They formed in outwash, in old stream sediments, or in kames in glacial deposits of mixed composition, primarily red sandstone, shale, and siltstone. Slopes are 0 to 8 percent.

Typical pedon of Birdsboro silt loam, 3 to 8 percent slopes, on the grounds of the Cedar Brook School, approximately 50 feet northeast of the intersection of Central Avenue and Butterfield Drive in Plainfield:

A—0 to 4 inches; very dark brown (10YR 2/2) silt loam; strong medium granular structure; friable; many fine and medium roots; slightly acid; clear smooth boundary.

AB—4 to 12 inches; dark brown (7.5YR 3/2) silt loam; moderate medium granular structure; friable; common fine and medium roots; strongly acid; clear smooth boundary.

Bt1—12 to 18 inches; brown (7.5YR 5/4) gravelly loam; moderate medium granular structure; friable; few medium and coarse roots; common distinct clay films lining interstitial pores and few distinct clay films on gravel-soil interfaces; about 15 percent fine and coarse rounded gravel derived from sandstone, shale, quartz, and basalt; strongly acid; clear smooth boundary.

Bt2—18 to 38 inches; reddish brown (5YR 4/4) gravelly sandy clay loam; moderate medium and coarse subangular blocky structure; friable; common distinct clay films lining interstitial pores; about 15 percent fine and coarse rounded gravel derived from sandstone, shale, quartz, and basalt; strongly acid; abrupt smooth boundary.

C—38 to 60 inches; reddish brown (2.5YR 4/4) gravelly loamy sand; single grain; loose; about 25 percent fine and coarse rounded gravel; strongly acid.

The solum thickness is 30 to 40 inches. The depth to bedrock is more than 5 feet. The content of rock fragments ranges from 0 to 20 percent in the solum and to as much as 60 percent in the C horizon, especially within kame areas where cobbles are dominant. Reaction is extremely acid to strongly acid in unlimed areas.

The A and AB horizons have hue of 5YR to 10YR, value of 2 to 4, and chroma of 2 to 4. Some pedons do not have an AB horizon.

The Bt horizon has hue of 2.5YR to 7.5YR, value of 4 or 5, and chroma of 4 to 6. The texture is silt loam, loam, sandy clay loam, or their gravelly analogs.

The C horizon has hue of 2.5YR or 5YR, value of 3 or 4, and chroma of 4 to 6. The texture mainly is loamy sand or sandy loam or the gravelly, very gravelly, or cobbly analogs. Some pedons have stratified layers of gravel.

Boonton Series

The soils of the Boonton series are coarse-loamy, mixed, mesic Typic Fragiudalfs. They are very deep, well drained and moderately well drained soils. They formed in glacial till derived from red sandstone, shale, gneiss, and basalt. Slopes are 0 to 35 percent.

Typical pedon of Boonton gravelly loam, 8 to 15 percent slopes, at the edge of a gully, 200 feet northwest of Prospect Picnic Area parking lot on W.R. Tracy Drive in the Watchung Reservation:

A—0 to 3 inches; very dark grayish brown (10YR 3/2) gravelly loam; moderate medium granular structure; very friable; many fine and medium roots; about 15 percent sandstone, shale, and basalt gravel; very strongly acid; clear smooth boundary.

BE—3 to 12 inches; brown (10YR 4/3) gravelly loam; moderate medium granular structure; very friable; many medium and coarse roots; about 20 percent shale, sandstone, and basalt gravel; very strongly acid; clear wavy boundary.

Bt1—12 to 24 inches; brown (7.5YR 5/4) gravelly fine sandy loam; moderate medium subangular blocky structure; friable; few fine and coarse roots; common distinct clay films; about 20 percent gravel and less than 5 percent cobbles of sandstone, shale, basalt, and gneiss; strongly acid; gradual wavy boundary.

Bt2—24 to 36 inches; reddish brown (5YR 5/4) gravelly fine sandy loam with large distinct strong brown (7.5YR 5/6) and few medium distinct pinkish gray (7.5YR 6/2) mottles; weak medium granular structure; very friable; common distinct clay films; about 20 percent gravel and cobbles of sandstone, shale, basalt, and gneiss; strongly acid; clear wavy boundary.

Btx—36 to 60 inches; reddish brown (5YR 4/4) loam; weak thick platy structure and massive in the lower part; very firm; brittle; common distinct clay films on ped-gravel interfaces; about 10 percent gravel and 2 percent cobbles of shale, sandstone, basalt, and gneiss; moderately acid.

The solum is 40 to 60 inches thick. The depth to bedrock is more than 5 feet. Rock fragment content ranges from 5 to 35 percent in the solum. Gravel and cobbles are dominantly sandstone, shale, and basalt with lesser amounts of quartz and gneiss. Cobble content is greater in the lower part of the solum and in the fragipan. Angular and rounded stones, cobbles, and boulders, dominantly derived from sandstone, shale, conglomerate, and basalt, are on the surface of some pedons. Basalt stones and boulders are dominant in the area of Summit. Reaction is very strongly acid or strongly acid in the upper part of the solum, strongly acid to slightly acid in the lower part of the solum, and moderately acid to neutral in the fragipan and substratum.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 2 to 4. The texture is loam or gravelly loam.

The BE or BA horizon, where present, has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 6. The texture is gravelly loam, fine sandy loam, or loam.

The Bt horizon has hue of 2.5YR to 7.5YR, value of 4 or 5, and chroma of 3 to 6. The texture is loam, fine sandy loam, sandy loam, or the gravelly analogs.

The Bx or Btx horizon has hue of 5YR to 7.5YR, value of 3 to 5, and chroma of 4 to 6. The texture is loam, fine sandy loam, sandy loam, or the gravelly or cobbly analogs.

The C horizon, where present, has hue of 2.5YR to 10YR, value of 3 to 6, and chroma of 3 to 6. The texture ranges from loam to loamy fine sand or the gravelly analogs. Consistency ranges from friable to firm.

Carlisle Series

The soils of the Carlisle series are euic, mesic Typic Medisaprists. They are very deep, very poorly drained organic soils. They formed in depressions that were or are partly occupied by lakes and ponds. Over a period of thousands of years, these lakes and ponds have been filling by the accumulation of organic material. Swamp areas such as Ashbrook and Galloping Hill are examples. Slopes are 0 to 2 percent.

Typical pedon of Carlisle muck, in an area of Carlisle-Adrian mucks, in an open area 50 feet southwest of a landfill on Fairway Drive, approximately 300 feet from the intersection of Fairway Drive and Morris Avenue, in Galloping Hill Park:

Oa1—0 to 8 inches; black (N 2.5/0) muck (sapric material); moderate fine granular structure; moderately acid; gradual smooth boundary.

Oa2—8 to 15 inches; dark reddish brown (5YR 3/2) fibers within (N 2.5/0) muck (sapric material); fibers are decomposed swamp grass and roots; moderately acid; gradual, wavy boundary.

Oa3—15 to 60 inches; dark reddish brown (5YR 2.5/2) muck (sapric material); about 40 percent fibers, less than 16 percent rubbed; slightly acid.

The organic deposit is more than 5 feet deep. Woody fragments exist in places and consist of decomposing roots and branches. Reaction throughout the pedon ranges from very strongly acid to mildly alkaline.

The surface tier is black. It is mainly sapric material and small amounts of hemic material.

The subsurface tier has hue of 5YR to 10YR or is neutral. It has value of 2 or 3 and chroma of 0 to 3. This tier is dominantly sapric material but has higher amounts of hemic material than the surface tier.

Dunellen Series

The soils of the Dunellen series are coarse-loamy, mixed, mesic Typic Hapludults. They are very deep, well drained soils. They formed in glacial outwash of mixed composition, mostly red sandstone, shale, gneiss, and basalt. These soils are mainly on contacts of glacial till with lacustrine deposits. Isolated areas are within areas that are dominantly glacial till. Slopes are 3 to 35 percent.

Typical pedon of Dunellen sandy loam, 3 to 8 percent slopes, on Scotch Plains municipal property, approximately 450 feet southeast of the intersection of Martine Avenue and Raritan Road in Scotch Plains:

A—0 to 4 inches; dark brown (7.5YR 4/2) sandy loam; moderate fine granular structure; very friable; many fine roots; very strongly acid; clear smooth boundary.

BE—4 to 8 inches; brown (7.5YR 5/4) sandy loam; moderate medium granular structure; very friable; many fine roots; very strongly acid; clear wavy boundary.

Bt—8 to 30 inches; yellowish red (5YR 4/6) sandy loam; moderate coarse subangular blocky structure; friable; common medium and coarse roots; few distinct clay bridges holding mineral grains together; about 10 percent rounded quartz, basalt, sandstone, and gneiss gravel; very strongly acid; gradual smooth boundary.

C1—30 to 58 inches; yellowish red (5YR 4/6) loamy sand; single grain; loose; about 10 percent fine rounded quartz, basalt, sandstone, and gneiss gravel; strongly acid; clear smooth boundary.

C2—58 to 60 inches; reddish brown (5YR 5/4) loamy

fine sand; single grain; loose; about 5 percent fine to coarse quartz and basalt gravel; very strongly acid.

The solum thickness ranges from 25 to 40 inches. The depth to bedrock is more than 5 feet. Rock fragments make up as much as 15 percent of the solum and as much as 50 percent of the substratum. Reaction ranges from very strongly acid to moderately acid.

The A horizon has hue of 5YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. The horizon is 1 to 4 inches thick.

The BE horizon has hue of 5YR or 7.5YR, value of 3 to 5, and chroma of 4 to 6. The texture is sandy loam or loam. Some pedons do not have a BE horizon.

The Bt horizon has hue of 2.5YR to 7.5YR, value of 3 to 5, and chroma of 4 to 6. The texture is sandy loam or loam.

The C horizon has hue of 2.5YR to 7.5YR, value of 3 to 5, and chroma of 4 to 6. The texture mainly is stratified loamy sand and sandy loam and gravelly analogs. Thin strata of loamy fine sand, silt loam, or fine sandy loam are at a depth of 40 to 60 inches. On level to nearly level slopes, wetness is in the C horizon.

Fluvaquents

Fluvaquents are very deep, somewhat poorly drained and poorly drained soils on flood plains. These soils commonly flood more than once a year. These soils formed in organic materials and in stratified and water-sorted sediments along the major streams. Slopes are 0 to 3 percent. Fluvaquents are commonly associated with Birdsboro and Haledon soils or with other wet soils that are subject to periodic flooding. A typical pedon is not given because these soils are so variable. Texture, soil drainage, organic content, and rock fragment content differ in these soils from place to place. Onsite investigations are required to determine soil properties for land use interpretations.

Haledon Series

The soils of the Haledon series are coarse-loamy, mixed, mesic Aquic Fragiudalfs. They are very deep, somewhat poorly drained soils. They formed in glacial till composed primarily of reddish sandstone and shale, basalt, and granitic gneiss. Slopes are 0 to 8 percent.

Typical pedon of Haledon loam, 0 to 3 percent slopes, in a wooded area, 200 feet south of a parking lot on the access road to Union College, 0.5 mile southeast on Gallows Hill Road from East Broad Street, on the border of Cranford and Westfield:

Oa—1 inch to 0; black (N 2/0) well decomposed organic matter; abrupt smooth boundary.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loam; strong coarse granular structure; friable; about 10 percent rock fragments; common fine and coarse and many medium roots; very strongly acid; abrupt smooth boundary.

Bt1—9 to 16 inches; yellowish brown (10YR 5/4) loam; coarse granular structure; friable; common distinct clay films lining interstitial pores; about 10 percent rock fragments composed of basalt, shale, sandstone, and granitic gneiss; common fine and medium roots; very strongly acid; gradual wavy boundary.

Bt2—16 to 28 inches; yellowish brown (10YR 5/4) silt loam; many medium and large pinkish gray (7.5YR 6/2) and strong brown (7.5YR 5/6) mottles; strong coarse angular blocky structure; friable; common distinct clay films on faces of peds; about 10 percent rock fragments composed of basalt, sandstone, shale, and granitic gneiss; many fine roots; very strongly acid; clear wavy boundary.

Btx—28 to 44 inches; reddish brown (5YR 4/4) sandy loam; common medium yellowish red (5YR 4/6) mottles; weak coarse prismatic structure; firm; slightly brittle; common faint clay films on faces of peds; about 10 percent basalt gravel; few fine roots; moderately acid; gradual wavy boundary.

Cd—44 to 60 inches; dark yellowish brown (10YR 4/4) gravelly loam; moderate coarse platy structure; very firm; about 15 percent basalt gravel; few fine roots; many fine black stains; slightly acid.

The solum is 40 to 60 inches thick (fig. 7). The fragipan is at a depth of 24 to 36 inches. Bedrock is at a depth of more than 5 feet. The content of rock fragments, dominantly subangular basalt, sandstone, shale, and granitic gneiss, ranges from 5 to 25 percent in the solum and from 15 to 35 percent in the Cd horizon. Few to many stones are throughout some pedons. Reaction is very strongly acid to slightly acid. The acidity decreases with depth.

The Ap horizon has hue of 7.5YR to 2.5Y, value mainly of 3 or 4, and chroma mainly of 2 to 4. In undisturbed areas, value of 2 or 3 and chroma of 1 or 2 are in any A horizon that is less than 5 inches thick.

The Bt horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 1 to 6. Chroma of 1 or 2 is only in the lower part. Low chroma mottles are in the upper 10 inches of the Bt horizon. Texture is loam, silt loam, fine sandy loam, or the gravelly or cobbly analogs.

The Btx horizon has variegated hue of 5YR to 10YR, value of 4 to 6, and chroma of 2 to 6. Texture is loam, sandy loam, fine sandy loam, or the gravelly analogs.

Figure 7.—The thick solum of silty material in the Haledon soil is used for nursery stock and vegetable crops.

The Cd horizon has hue of 2.5YR to 7.5YR, value of 3 to 6, and chroma of 2 to 6. The texture is loam or sandy loam or the gravelly analogs.

Hasbrouck Series

The soils of the Hasbrouck series are fine-loamy, mixed, mesic Aeric Fragiudalfs. They are very deep, poorly drained soils. They formed in glacial till composed primarily of red sandstone, shale, basalt, and granitic gneiss. Slopes are 0 to 3 percent.

Typical pedon of Hasbrouck silt loam, 0 to 3 percent slopes, in a wooded area 600 feet northwest of the cul-de-sac at the end of Knollwood Court in Plainfield:

Oa—2 inches to 0; black (5YR 2.5/1) well decomposed organic material.

A—0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam; moderate medium granular structure; very friable; many fine and medium roots; very strongly acid; abrupt smooth boundary.

Eg—10 to 16 inches; light brownish gray (10YR 6/2) sandy loam; few fine prominent strong brown (7.5YR 5/6) mottles; strong medium granular structure; friable; common medium roots; about 5 percent fine and sandstone and shale gravel; very strongly acid; gradual wavy boundary.

Btg1—16 to 26 inches; light gray (10YR 7/1) loam; many large prominent brownish yellow (10YR 6/8) mottles; strong medium angular blocky structure; friable; common medium and coarse roots; common distinct clay films lining interstitial pores and on gravel-soil interfaces; about 3 percent shale and sandstone gravel; very strongly acid; gradual wavy boundary.

Btg2—26 to 30 inches; gray (10YR 5/1) clay loam; many medium prominent brownish yellow (10YR 6/6) mottles; strong coarse angular blocky structure; firm; few coarse roots; many distinct clay films lining interstitial pores; strongly acid; clear wavy boundary.

Bx—30 to 52 inches; about 50 percent light gray (10YR 7/1) and 50 percent reddish brown (5YR 5/4) loam; many large prominent strong brown (7.5YR 5/8) mottles; strong thin platy structure; very firm; strongly acid; gradual wavy boundary.

C—52 to 60 inches; red (2.5YR 4/6) loam; common large prominent light gray (10YR 7/1) mottles; weak thin platy structure to massive in some parts; firm; strongly acid.

The solum is 24 to 48 inches thick. The fragipan is at a depth of 18 to 36 inches. The depth to bedrock is more than 5 feet. Rock fragments that are dominantly

red sandstone, shale, and basalt make up 5 to 15 percent of the solum and 5 to 20 percent of the C horizon. Reaction ranges from very strongly acid to moderately acid in the part of the solum above the fragipan and from strongly acid to slightly acid in the fragipan and C horizon.

The A horizon has hue of 7.5YR to 10YR, value of 2 to 4, and chroma of 1 or 2.

The Eg horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma mainly of 1 or 2. Mottles with higher chroma are common. The texture is sandy loam or loam.

The Btg horizon has hue of 2.5YR to 10YR, value of 3 to 7, and chroma mainly of 1 or 2. Mottles with higher chroma are common. The texture is clay loam or loam.

The Bx horizon has hue of 2.5YR to 10YR, value of 3 to 7, and chroma of 1 to 8. The texture is loam or sandy loam and 10 to 20 percent clay content. The Bx horizon is very firm in place.

The C horizon has hue of 10R to 10YR, value of 3 to 7, and chroma of 0 to 6. It is firm in some areas. Texture is loam to loamy sand.

Neshaminy Series

The soils of the Neshaminy series are fine-loamy, mixed, mesic Ultic Hapludalfs. They are deep and very deep, well drained soils. They formed from residuum of basalt on side slopes and ridgetops of the Watchung Mountains. Slopes are 3 to 45 percent.

Typical pedon of Neshaminy silt loam, extremely stony, 200 feet north of an unnamed, unpaved road about 1,400 feet south of Diamond Hill Church in Berkeley Heights, and about 500 feet west of Diamond Hill Road:

A—0 to 2 inches; dark brown (7.5YR 3/2) silt loam; weak fine granular structure; very friable; common fine roots; very strongly acid; abrupt smooth boundary.

E—2 to 5 inches; brown (10YR 4/3) loam; weak medium granular structure; very friable; common medium and many coarse roots; very strongly acid; clear wavy boundary.

B—5 to 14 inches; reddish brown (5YR 4/4) cobbly silt loam; moderate medium subangular blocky structure; friable; common medium and coarse roots; about 30 percent angular basalt cobbles; strongly acid; gradual wavy boundary.

Bt—14 to 28 inches; yellowish red (5YR 4/6) gravelly clay loam; strong medium and coarse angular blocky structure; firm; common medium roots; many distinct clay films lining interstitial pores and on ped-gravel interfaces; about 30 percent fine and coarse basalt gravel; few angular cobbles; moderately acid; clear wavy boundary.

BC—28 to 42 inches; brown (7.5YR 4/4) cobbly clay loam; moderate medium subangular blocky structure; friable; few medium roots; about 30 percent basalt cobbles; moderately acid; gradual wavy boundary.

C—42 to 60 inches; reddish brown (5YR 4/4) cobbly silt loam; massive; friable; about 10 percent black coatings; about 30 percent basalt cobbles; moderately acid.

The solum thickness is 40 to 50 inches. Bedrock is at a depth of more than 4 feet. The content of rock fragments range from 0 to 40 percent by volume in individual horizons. The amount of rock fragments generally increases with depth. Cobbles and gravel are dominant. Stones cover 3 to 15 percent of the surface in most areas. Reaction ranges from very strongly acid to moderately acid, generally becoming less acid with increasing depth.

The A horizon has hue of 7.5YR to 10YR, value of 2 to 4, and chroma of 1 to 3.

The E horizon has hue of 7.5YR to 10YR, value of 4 or 5, and chroma of 2 to 4. The texture is silt loam or loam or the cobbly and gravelly analogs.

The Bt horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. The texture is silt loam, loam, clay loam, or the gravelly or cobbly analogs.

The C horizon has hue of 5YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. The texture is sandy loam, silt loam, loam, or the gravelly or cobbly analogs.

Parsippany Series

The soils of the Parsippany series are fine, mixed, mesic Aeric Ochraqualfs. They are very deep, poorly drained soils. They formed from stratified sediments of lacustrine origin and derived mostly from red and brown shale, sandstone, basalt, and granitic rocks. These soils are on the nearly level bottom of the basin formerly occupied by the glacial Lake Passaic along what is now the Passaic River basin in Berkeley Heights and New Providence. Slopes are 0 to 3 percent.

Typical pedon of Parsippany silt loam, 0 to 3 percent slopes, in powerline area 250 feet northeast of the intersection of Central Avenue and the powerline, along the Passaic River Parkway in New Providence:

A—0 to 3 inches; dark gray (5YR 4/1) silt loam; moderate medium granular structure; friable; many fine roots; very strongly acid; abrupt smooth boundary.

ABg—3 to 8 inches; gray (10YR 6/1) silt loam; many

fine prominent strong brown (7.5YR 5/6) mottles; moderate medium and coarse granular structure; friable; many fine roots; very strongly acid; clear smooth boundary.

Btg1—8 to 18 inches; light gray (10YR 6/1) silty clay loam; many coarse prominent strong brown (7.5YR 5/8) and many coarse prominent brownish yellow (7.5YR 6/8) mottles; moderate medium and coarse subangular blocky structure; firm; common fine roots; many prominent clay films lining interstitial pores and on faces of peds; strongly acid; gradual wavy boundary.

Btg2—18 to 45 inches; reddish brown (5YR 5/3) silty clay; many coarse prominent strong brown (7.5YR 5/6) and many coarse prominent gray (N 6/0) mottles; weak thick platy structure; very firm; common prominent clay films lining interstitial pores and on faces of peds; moderately acid; gradual wavy boundary.

C—45 to 60 inches; reddish brown (5YR 5/3) silty clay loam; many coarse prominent gray (N 6/0) mottles; massive; firm; slightly acid.

The solum is 40 to 60 inches thick. The depth to bedrock is more than 5 feet. There are very few or no rock fragments. Reaction ranges from very strongly acid near the surface layer to slightly acid in the lower part of the pedon.

The A horizon has hue of 5YR to 10YR, value of 3 or 4, and chroma of 1 or 2.

The ABg horizon has hue of 5YR to 10YR, value of 4 to 7, and chroma of 1 to 8. It has dominantly fine mottles with high chroma. The texture is silt loam or silty clay loam. Some pedons do not have an ABg horizon.

The Btg horizon has hue of 7.5YR to 2.5Y, value of 4 to 7, and chroma of 1 to 8. The horizon has mottles with high chroma. The matrix color has chroma of more than 2 in some part of the horizon. The texture is silty clay loam, silty clay, or clay.

The C horizon has hue of 2.5YR to 2.5Y, value of 4 to 7, and chroma of 0 to 8. The texture is dominantly silty clay loam but has strata of loamy sand to silt loam.

Passaic Series

The soils of the Passaic series are clayey over sandy or sandy-skeletal, mixed, mesic Aeric Ochraqualfs. They are very deep, poorly drained soils. They formed in clayey over sandy, stratified, glaciolacustrine sediments. Slopes are 0 to 3 percent.

Typical pedon of Passaic silt loam in a wooded area about 500 feet southeast of the intersection of Terrible Road and Raritan Road, 200 feet west of the southwest corner of the parking lot of the Ashbrook Convalescent Center, and 50 feet west of the powerline right-of-way in Scotch Plains:

A—0 to 4 inches; black (10YR 2/1) silt loam; moderate coarse granular structure; very friable; many fine and medium roots; strongly acid; clear smooth boundary.

ABg—4 to 10 inches; dark gray (10YR 4/1) silt loam; strong fine and medium granular structure; very friable; common medium roots; strongly acid; abrupt smooth boundary.

Btg1—10 to 16 inches; light gray (10YR 6/1) silty clay loam; many medium prominent brownish yellow and strong brown mottles; moderate medium and coarse subangular blocky structure; very friable; few fine and medium roots; many distinct clay films lining pores; slightly acid; gradual wavy boundary.

Btg2—16 to 24 inches; light gray (10YR 6/1) silty clay; many coarse prominent strong brown and common medium prominent brownish yellow mottles; moderate coarse angular blocky structure; very firm; few fine roots; many distinct clay films lining pores; few fine quartz pebbles; neutral; clear smooth boundary.

Btg3—24 to 28 inches; gray (N 6/0) clay loam with common coarse prominent weak red and yellowish brown mottles; weak medium and coarse subangular blocky structure; firm; few fine roots; many distinct clay films lining pores; few fine quartz pebbles; neutral; abrupt smooth boundary.

2C—28 to 60 inches; reddish brown (5YR 4/4) gravelly loamy sand; few coarse distinct brown mottles; single grain; about 15 percent gravel of dominantly well rounded fine to coarse sandstone, shale, and basalt pebbles; few angular basalt and granitic gneiss pebbles; neutral.

The thickness of the solum is commonly about 30 inches but ranges from 24 to 35 inches. The depth to bedrock is more than 5 feet. There generally are no rock fragments, but the range is as much as 10 percent in subhorizons in the solum. Gravelly or very gravelly layers or lenses are common in the substratum. The particle size control section is between the top of the Btg horizon to a depth of 39 inches. The content of clay in the subhorizons in the solum ranges from 25 to 60 percent, but the weighted average of the upper part of the control section ranges from 35 to 50 percent. The lower part of the control section has contrasting sandy or sandy-skeletal material with less than 15 percent clay, less than 30 percent silt, and more than 70 percent fine sand or

coarser. Unless limed, the solum ranges from very strongly acid to neutral and the C horizon is neutral or alkaline.

The A horizon has hue of 7.5YR to 10YR, value of 2 to 4, and chroma 1 or 2. The Ap horizon, where present, has hue of 7.5YR to 10YR, value of 3 to 5, and chroma of 1 or 2.

The ABg horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 0 to 2. Texture is loam or silt loam.

The Btg horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 0 to 2. Texture is silt loam, clay loam, silty clay loam, clay, or silty clay.

The C horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 3 to 6. Texture is dominantly sand, fine sand, or very gravelly sand in all pedons. In most places the sand fraction is dominated by medium or fine sand. Textures range from sandy loam tc very gravelly sand in lenses or strata or are clayey or silty in varves.

Raritan Series

The soils of the Raritan series are fine-loamy, mixed, mesic Aquic Fragiudalfs. They are very deep, somewhat poorly drained soils. They formed in glacial outwash and stream terrace sediments. Slopes are 0 to 3 percent.

Typical pedon of Raritan silt loam, 0 to 3 percent slopes, in a wooded area 50 feet southwest of the driveway to Saint Helen's Church parking lot, approximately 0.2 mile southwest along Lamberts Mill Road from the intersection of Lamberts Mill Road and Rahway Avenue in Westfield:

Ap—0 to 8 inches; dark brown (10YR 3/3) silt loam; moderate fine and medium granular structure; very friable; common fine and medium roots; moderately acid; abrupt smooth boundary.

AB—8 to 12 inches; brown (7.5YR 5/4) loam; moderate medium granular structure; friable; common medium roots; few distinct clay films lining interstitial pores; moderately acid; gradual wavy boundary.

Bt—12 to 22 inches; brown (7.5YR 5/4) loam; many medium prominent strong brown (7.5YR 5/8) and many medium distinct pinkish gray (7.5YR 6/2) mottles; moderate medium angular blocky structure; friable; common medium roots; few distinct clay films lining interstitial pores and ped faces; about 3 percent medium and coarse gravel; moderately acid; clear smooth boundary.

Bx1—22 to 28 inches; light gray (10YR 7/1) clay loam; many large, prominent strong brown (7.5YR 5/8) and few medium, prominent brownish yellow (10YR 6/6) mottles; weak prismatic structure; firm; few medium roots; about 5 percent rounded sandstone and shale gravel; moderately acid; gradual wavy boundary.

Bx2—28 to 36 inches; about 70 percent light gray (10YR 7/1) and 30 percent strong brown (7.5YR 4/6) loam; many coarse prominent, brownish yellow (10YR 6/6) and strong brown (7.5YR 5/8) mottles; weak prismatic structure; firm; few fine roots; about 3 percent gravel; slightly acid; abrupt smooth boundary.

2C1—36 to 40 inches; reddish brown (5YR 4/4) loamy sand; few medium prominent yellowish red (5YR 5/8) mottles; single grain; loose; slightly acid; clear smooth boundary.

2C2—40 to 60 inches; reddish brown (5YR 4/4) loamy sand; single grain; loose; thin sandy clay loam varve; slightly acid.

The solum is 20 to 40 inches thick. The depth to bedrock is more than 5 feet. The content of rock fragments, mainly sandstone and shale gravel, ranges from 0 to 10 percent. Reaction is medium acid or strongly acid.

The A horizon has hue of 5YR to 10YR, value of 2 to 4, and chroma of 1 to 3.

The AB horizon has hue of 5YR to 10YR, value 4 to 7, and chroma of 4 to 8. It has high chroma mottles in some pedons. The texture is silt loam or loam. Some pedons do not have an AB horizon.

The Bt horizon has hue of 2.5YR to 7.5YR and value and chroma of 4 to 6. It is mottled with low chroma and high chroma mottles. The texture is silty clay loam, silt loam, loam, or clay loam.

The Bx horizon has hue of 2.5YR to 10YR, value of 4 to 7, and chroma of 1 to 6. It is mottled with low chroma and high chroma mottles. The texture is silty clay loam, silt loam, loam, or clay loam.

The 2C horizon has hue of 2.5YR to 10YR, value of 3 to 7, and chroma of 1 to 6. It has low and high chroma mottles in some pedons. The texture is dominantly loamy sand. There are stratified thin layers of fine sandy loam to silty clay in some pedons.

Sulfaquents

Sulfaquents are very deep, poorly drained or very poorly drained mineral soils that are subject to tidal flooding. These soils formed in stratified silty and sandy sediments of glaciated origin. The soils are on tidal flats. Slopes are 0 to 1 percent.

A typical pedon is not given because these soils are so variable. The thickness of silty strata ranges from 10 to more than 50 inches. In most places the top 10 inches are organic matter and there are buried thin

strata or lenses of fibrous or mucky layers. The mineral layers to a depth of 60 inches mainly are silty clay loam but range to gravelly loamy sand. The substratum is gravelly and sandy.

These soils are strongly acid to slightly acid but become more acid when exposed to air.

Sulfihemists

Sulfihemists are very deep, poorly drained or very poorly drained organic soils that are subject to tidal flooding. The organic soils are underlain by stratified silty and sandy sediments of glaciated origin. These soils are on tidal flats. Slopes are 0 to 1 percent.

A typical pedon is not given because these soils are so variable. The thickness of the organic surface layer ranges mainly from 20 to 60 inches or more. The subsoil in most places is silty clay but ranges to gravelly loamy sand. The substratum in most places is gravelly loamy sand. These soils are strongly acid to slightly acid but become more acid when exposed to air.

Tunkhannock Series

The soils of the Tunkhannock series are loamy-skeletal, mixed, mesic Typic Dystrochrepts. They are very deep, well drained soils. They are on glacial outwash terraces or kames. Slopes are 25 to 35 percent.

Typical pedon of Tunkhannock gravelly loam, 25 to 35 percent slopes, approximately 100 feet east of the bridge at the outlet of Echo Lake in Echo Lake Park:

Oa—2 inches to 0; very dark gray (5YR 3/1) highly decomposed organic material; strong fine granular structure; very friable; many fine to coarse roots; extremely acid; abrupt smooth boundary.

A—0 to 3 inches; dark reddish brown (5YR 3/3) gravelly loam; moderate medium granular structure; very friable; many fine to coarse roots; about 15 percent gravel and 5 percent cobbles; extremely acid; clear wavy boundary.

Bw—3 to 20 inches; yellowish red (5YR 4/6) very cobbly loam; weak fine granular structure; very friable; many fine to medium and few coarse roots; about 40 percent sandstone, shale, basalt, and gneiss cobbles and gravel; very strongly acid; gradual wavy boundary.

BC—20 to 28 inches; reddish brown (5YR 4/4) very cobbly sandy loam; very weak fine granular structure; very friable; few fine to medium roots; about 40 percent rock fragments, mainly cobbles; very strongly acid; clear wavy boundary.

C—28 to 60 inches; reddish brown (5YR 4/4) very cobbly loamy sand; single grain; loose; about 40 percent rock fragments; very strongly acid.

Thickness of the pedon over sandy substrata ranges from 24 to 36 inches. The depth to bedrock is more than 5 feet. The content of rock fragments range from 15 to 60 percent by volume in individual horizons of the solum and from 40 to 60 percent in the C horizon. The rock fragments are dominantly rounded sandstone and siltstone and, in some pedons, granitic gneiss and basalt.

The A horizon has hue of 5YR to 10YR, value of 3 to 5, and chroma of 2 or 3.

The Bw horizon has hue of 5YR to 7.5YR, value of 4 or 5, and chroma of 3 to 6. The texture is very cobbly or very gravelly loam or sandy loam.

The C horizon and BC horizon have hue of 5YR to 7.5YR, value of 4 or 5, and chroma of 3 to 6. Th texture is very gravelly or very cobbly, sandy loam, loamy sand, or sand. Some pedons do not have a BC horizon.

Udifluvents

Udifluvents are very deep, moderately well drained or somewhat poorly drained, alluvial soils that are subject to flooding. These soils are along both perennial and intermittent streams. Slopes are 0 to 5 percent.

A typical pedon is not given because these soils are so variable. These soils have 6 to 20 inches of recent sandy alluvium on the surface. The surface is underlain by 3 to 15 inches of dark brown, loamy soil and a subsoil of 20 to 40 inches of stratified sandy or silty soil.

Udorthents

Udorthents are moderately deep to very deep, well drained to poorly drained soils. These soils were formed to create sites for development or as a product of sanitary landfills. These soils are mostly at the edges of low, nearly level wetlands. Slopes are 0 to 45 percent.

A typical pedon is not given because these soils are so variable. The sources of fill and the areas that have been leveled are so varied that the soils have diverse textural and mineralogical composition. In areas of old sanitary landfills, the upper 2 to 4 feet are usually free of nonearthy trash and garbage, but in many places these materials are mixed throughout the soil. Glass, metal, and plastic fragments are common, particularly below 2 feet. In the cut and fill areas that were prepared for building sites, local loamy materials have been mixed during construction to variable depths. In

fill areas the underlying soils are mostly poorly drained. In cut areas the underlying materials are loamy and contain silty strata. Areas underlain by old tidal marsh soils consist in some places of thick organic (Sulfihemists) soils and in other places of silty, loamy and or sandy (Sulfaquents) soils.

Whippany Series

The soils of the Whippany series are fine, mixed, mesic Aquic Hapludalfs. They are very deep, somewhat poorly drained soils. They formed from stratified sediments of lacustrine origin, derived mostly from red and brown shale and sandstone, basalt, and granitic rocks. There are few or no rock fragments. These soils are the edge of a basin formerly occupied by the glacial Lake Passaic. The area is now the Passaic River Basin in Berkeley Heights and New Providence. Slopes are 0 to 8 percent.

Typical pedon of Whippany silt loam, 0 to 3 percent slopes, along the western side of a ditch approximately 300 feet north-northwest of the intersection of Garfield Street and River Road in Berkeley Heights:

A—0 to 4 inches; dark brown (7.5YR 3/2) silt loam; moderate medium granular structure; friable; many fine and common coarse roots; strongly acid; abrupt smooth boundary.

BE—4 to 15 inches; yellowish brown (10YR 5/4) silt loam; many fine prominent strong brown (7.5YR 5/8) mottles; moderate medium and coarse granular structure; friable; common medium and few coarse roots; common distinct clay films lining interstitial pores; strongly acid; clear wavy boundary.

Bt—15 to 44 inches; yellowish brown (10YR 5/4) silty clay; many coarse prominent light gray (2.5Y 7/2) and strong brown (7.5YR 4/6) mottles; strong thick platy structure; very firm; many prominent clay films on faces of peds; slightly acid.

C—44 to 60 inches; brown (7.5YR 4/4) silty clay loam; many light gray (2.5Y 7/2) and strong brown (7.5YR 4/6) mottles; massive; firm, plastic; slightly acid.

The solum is 40 to 50 inches thick. The depth to bedrock is more than 5 feet. Rock fragments make up less than 5 percent of the profile. Reaction ranges from strongly acid near the surface to slightly acid in the lower horizons.

The A horizon has hue of 7.5YR or 10YR, value of 3, and chroma of 2.

The BE horizon has hue of 7.5YR or 10YR, value of 3 to 5, and chroma of 4 to 6. Texture is silt loam. Some pedons do not have a BE horizon.

The Bt horizon has mixed hue of 5YR to 10YR, value of 3 to 5, and chroma of 4 to 6. Typically, the higher chroma colors are not dominant. Both high and low chroma mottles are present, particularly on faces of peds. Texture is silty clay, silty clay loam, or clay, and the weighted average is more than 35 percent clay.

The C horizon has hue of 5YR to 7.5YR, value of 3 to 5, and chroma of 3 or 4. Texture is dominantly silty clay loam but ranges to loamy sand, sandy loam, loam, or silt loam in lenses or strata.

Formation of the Soils

This section describes the factors and processes of soil formation.

Factors of Soil Formation

The five factors that normally influence soil development are parent material, climate, plant and animal life, relief, and time. Each of these factors functions interdependently with the other factors. Changes in one factor can change the effects of the others. In some areas, one factor may dominate the formation of a soil and determine most of its properties. In Union County, the main factors that affect local variations in the soils are parent material, relief, and human influences.

Soils in the urban and suburban environment of Union County have been greatly influenced by the activities of people. For example, using bulldozers and other earth moving equipment, people have destroyed some soils while creating or modifying others.

Parent Material

Parent material is the unconsolidated organic and mineral mass from which a soil is formed. In the early stages of soil development, properties that are inherited from the parent material are the most evident. Later these properties are modified, and the soil acquires characteristics of its own, but the type of parent material determines the texture and mineral composition of the soil.

Union County lies entirely in the Piedmont physiographic province, though the eastern half of the county is covered with an overburden of glacial material *(12)*. The soils formed in four general types of materials: residual material derived from the weathering of Piedmont rock; unconsolidated sediments from glacial outwash and ancient lake materials overlying Piedmont rock; recent alluvial sediments from eroded Piedmont and glacial outwash slopes; and mixed fill material of rock fragments, sand, silt, clay, inorganic objects, and organic material.

Residual material derived from the weathering of Piedmont rocks is mainly on the ridges and side slopes of the Watchung Mountains. This residual material is derived from basalt rock that was formed by the rapid cooling of lava flowing on the ground surface. Weathering of the basalt rock has produced the Neshaminy and Amwell soils.

During the Wisconsin age, an ice sheet flowed over the entire area of what is now Union County. The ice sheet pushed earth and rock ahead of it. As the meltwater poured from the glacier, the water carried gravel, sand, silt, and clay with it. This material is called glacial outwash. The main depositional area is in the valley between the Watchung Mountains and the foot slopes of the Watchungs from Summit to Plainfield. The Birdsboro, Dunellen, and Raritan soils formed in glacial outwash. Tunkhannock soils formed in the very gravelly material of kames and eskers left by the retreating ice sheet. When the ice melted, it also left a glacial ground moraine as much as 90 feet thick, from which the Haledon, Hasbrouck, and Boonton soils formed. Ancient lakes created by the meltwater and retreat of the glacier also covered large areas of Union County. The former lakebeds were filled with stratified sediments of clay, silt, and sand. Parsippany, Passaic, and Whippany soils formed in these old glaciolacustrine sediments.

Recent alluvial sediments consist of material that has been eroded from the Piedmont rock and glacial material. Some areas with remnant glacial lakes and ponds have filled during recent geologic history with organic material and mineral sediments. The Adrian and Carlisle soils formed in these highly organic materials. Sulfaquents, Sulfihemists, Fluvaquents, and Udifluvents are soils that are flooded frequently, either by tidal water or by freshwater from streams and rivers yearly. These soils formed in the sediments and organic material that is deposited or renewed by yearly flooding.

A large part of Union County is made up of soils that formed in parent material that has been deposited or radically disturbed by people. The soils that formed on cuts and similar excavation surfaces or resulting fill areas have commonly been mapped as Udorthents, loamy. Areas of tidal marsh that were covered by fill for construction sites and sanitary landfills were mapped as Udorthents, organic substratum. Areas of sanitary landfills were mapped as Udorthents, waste

substratum. The Udorthents that have organic and waste substratums have a high concentration of nonmineral artifacts mixed in the fill material.

Climate

Climate affects the physical, chemical, and biological properties of the soil through the influence of rainfall and temperature. Water supports biological activity. It dissolves and transports minerals and organic residues down through the soil profile. Also, it influences the weathering of rocks and minerals and the removal and deposition of material by erosion. The amount of water that moves through a soil is determined by the amount of rainfall, the relative humidity, the temperature, the degree of slope, the rate of infiltration, and the permeability in the soil. Temperature influences the kind and amount of plants, the kinds of animals and their activities, and the rate of chemical and physical processes that are part of weathering and soil formation.

The soils of Union County formed in a temperate, moist climate that probably was not greatly different from that of the present. The present average annual precipitation is about 49 inches. The average annual temperature is about 53 degrees F. Rainfall distribution is fairly uniform throughout the year. Winters are typically short, and there are only brief periods when the temperature is extremely low. Summer periods of high temperature are usually short.

Climate varies slightly throughout the county. However, these differences have been too small to be reflected in generalized soil properties. As an example, slightly cooler temperatures and a shorter growing season are common at the higher elevations away from the urban areas. Also, urban heat in downtown areas of Elizabeth and Newark may make average soil temperatures somewhat higher. Greater extremes in temperature may occur around buildings.

The temperature and rainfall in Union County encourage the almost continuous weathering of rocks and minerals. Under these favorable conditions, soluble minerals and fine particles are leached by water from the surface layer into the subsoil or ground water. Soluble bases, such as calcium and magnesium, and clay minerals have been moved into the lower horizons or out of the soils altogether.

Many of the soils of the county were deposited by water. In those soils, most of the soluble bases were already dissolved and washed away before deposition. The high rainfall has further removed what bases were there, so that nearly all of the soils have a pH of 4 or 5 in their natural condition. Those soils that formed in glacial till (Boonton, Haledon, and Hasbrouck soils) have large amounts of carbonates. With weathering, these carbonates have moved downward into the subsoil and substratum or out of the soil.

Plant and Animal Life

All living organisms, including vegetation, bacteria, fungi, and animals, are important to soil formation.

Vegetation can influence the amount of runoff, erosion, available water, and organic matter in the soil. Leaves, grasses, twigs, or crops add organic matter to the soil. In forested areas, leaf litter, twigs, and decayed roots make up the organic surface horizons and darken the A horizon. In open fields, cultivated areas, and suburban yard grasses and crop residue darken the Ap horizon (plow layer).

Trees and other plants bring plant nutrients from the lower part of the soil to the upper layers. Vegetation also forms a protective cover that slows the erosion process and influences soil temperature. Channeling by roots and the uprooting of trees also mixes soil material. The organic matter added by plants alters the chemical processes in the soil and results in the formation of humus.

Earthworms, insects, and other small animals add organic matter to the soil and mix soil material, making the soil more porous for water and air to infiltrate it. Bacteria, fungi, and other micro-organisms break down plant and animal residues. In areas where a high water table restricts micro-organism growth and processes, soils will build up a large amount of organic materials in the surface layer and subsoil, as in the Adrian, Carlisle, and Sulfihemists soils.

The changes that people have caused in soils are most noticeable in areas where the soils have been eroded, drained, excavated, or filled. A number of human activities also influence soil development by changing the nature and properties of soils. These include cultivating, applying fertilizer, or landscaping. Also included are walking or driving over the soil, which causes compaction. Though most of these changes (except for major land forming operations) are slow, they become a dominant force in soil development because of the extent and magnitude of the alterations.

Relief

Relief affects soil formation through its influence on drainage, erosion, plant cover, and soil temperature. Soils on flood plains, on broad flats, or in depressions are generally wetter than soils on better drained, upland positions. The subsoil will have mottling, produced from the alternate wetting and drying of the soil layers as the water table fluctuates up and down. Red colors in

the soil are caused by the oxidation of iron. Gray colors are caused by the reduction and removal of iron. An example of a wet soil with mottling and gray colors is the poorly drained Parsippany soil. Soils on flood plains that are flooded frequently, such as Udifluvents, are constantly being altered. Consequently, they have less profile development than soils on uplands or terraces, such as the Birdsboro or Dunellen soil.

Relief greatly affects the potential for erosion. The danger of erosion is much greater on the steeper upland soils than on the soils that are nearly level or on broad flats. Gently sloping soils also show more development than steeper soils, because excess water runs either through or off the soil without excessive erosion. This process allows soils to develop from parent material at a faster rate than that of the soils with a greater erosion hazard.

In Union County, human activity has complicated the analysis of relief as a factor in how soil forms. Most soils on man-made land surfaces are too disturbed to show differences in color and other properties that are normally associated with topographic differences. By shaping the land and making new landforms, people have often changed drainage relationships and thereby changed some of the chemical and physical processes in the soils. Udorthents are an example of soils that people have created or strongly altered.

Time

The time needed for a soil to form depends on the influences of the other soil-forming factors. Soil takes less time to form in a warm, moist climate than in a cool, dry climate. Also, some parent materials are more resistant to weathering than others. For instance, quartz is a very hard mineral and may change very little by weathering, even if it is exposed to the elements for centuries, as in the Tunkhannock soil. This soil shows less development than similar-age soils with less quartz in their earthy material. Thus, the age of a soil is measured by the degree of profile development, rather than by the number of years that the soil has taken to form.

Very youthful soils, such as those formed in recent alluvium or in materials recently deposited by people, are essentially unaltered parent material. Examples are Fluvaquents, Udifluvents, and Udorthents. They have indistinct soil horizons or little other evidence of soil development.

Soil scientists call a soil mature when it has acquired a well developed profile. Soils with a well developed profile may be deep (more than 40 inches) to bedrock, have distinct horizons of color, or show distinct horizons with clay movement to the subsoil. Examples of mature soils are Neshaminy, Dunellen, and Boonton soils.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

Ablation till. Loose, permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Back slope. The geomorphic component that forms the steepest inclined surface and principal element of many hillsides. Back slopes in profile are commonly steep, are linear, and may or may not include cliff segments.

Basal till. Compact glacial till deposited beneath the ice.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedding system. A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on the contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

California bearing ratio (CBR). The load-supporting capacity of a soil as compared to that of a standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Capillary water. Water held as a film around soil

particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Cement rock. Shaly limestone used in the manufacture of cement.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Climax plant community. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Cobbly soil material. Material that is 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation cropping system. Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the effects of the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosion. Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cropping system. Growing crops according to a planned system of rotation and management practices.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Delta. A body of alluvium having a surface that is nearly flat and fan shaped; deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth, soil. Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches, shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are

frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Erosion pavement. A layer of gravel or stones that remains on the surface after fine particles are removed by sheet or rill erosion.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, and clay.

Firebreak. Area cleared of flammable martial to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of firefighters and equipment. Designated roads also serve as firebreaks.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Fragile (in tables). A soil that is easily damaged by use or disturbance.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial

drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Graded stripcropping. Growing crops in strips that grade toward a protected waterway.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hardpan. A local term used for any hard soil layer that is difficult to excavate. (See "Basal till," "Dense basal till," and "Pan.")

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A, are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious

bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Very low	Less than 0.2
Low	0.2 to 0.4
Moderately low	0.4 to 0.75
Moderate	0.75 to 1.25
Moderately high	1.25 to 1.75
High	1.75 to 2.5
Very high	More than 2.5

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Karst (topography). The relief of an area underlain by limestone that dissolves in differing degrees, thus forming numerous depressions or small basins.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low-residue crops. Such crops as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mesa. A broad, nearly flat topped and commonly isolated upland mass characterized by summit widths that are more than the heights of bounding erosional scraps.

Metamorphic rock. Rock of any origin altered in

mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Narrow-base terrace. A terrace no more than 4 to 8 feet wide at the base. A narrow-base terrace is similar to a broad-base terrace, except for the width of the ridge and channel.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil; and carbon, hydrogen,and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition. The count of organic matter in the surface layer is described as follows:

Very low	less than 0.5 percent
Low	0.5 to 1.0 percent
Moderately low	1.0 to 2.0 percent
Moderate	2.0 to 4.0 percent
High	4.0 to 8.0 percent
Very high	more than 8.0 percent

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial meltwater.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are—

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches

Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plinthite. The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Ultra acid	less than 3.5
Extremely acid	3.5 to 4.4
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk

density, and the lowest water content at saturation of all organic soil material.

Saprolite (soil science). Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio. The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. A small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Sloughed till. Water-saturated till that has flowed slowly downhill from its original place of deposit by glacial ice. It may rest on other till, on glacial outwash, or on a glaciolacustrine deposit.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

Millimeters

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Talus. Fragments of rock and other soil material accumulated by gravity at the foot of cliffs or steep slopes.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Toxicity (in tables). Excessive amount of toxic substances, such as sodium or sulfur, that

severely hinder establishment of vegetation or severely restrict plant growth.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve. A sedimentary layer of a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow. The uprooting and tipping over of trees by the wind.

Tables

Table 1.--Temperature and Precipitation

(Recorded in the period 1951-78 at Plainfield, New Jersey)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average daily	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	38.0	22.0	30.0	62	-1	24	3.43	1.86	4.81	7	8.2
February----	41.5	23.7	32.6	65	1	26	3.34	2.23	4.34	6	8.7
March-------	50.1	30.7	40.4	77	13	99	4.45	3.13	5.65	8	6.0
April-------	62.7	39.9	51.4	88	24	342	3.88	2.45	5.16	7	0.5
May---------	72.7	49.1	61.0	93	31	651	4.01	2.23	5.58	8	0.0
June--------	81.5	58.6	70.1	98	44	903	3.45	1.66	4.98	7	0.0
July--------	86.1	63.4	74.7	99	50	1,076	4.84	2.15	7.13	7	0.0
August------	84.3	62.3	73.3	96	46	1,032	5.53	2.57	8.07	7	0.0
September---	77.4	55.3	66.4	95	35	792	4.01	1.78	5.91	6	0.0
October-----	66.9	44.1	55.5	85	25	481	3.64	1.83	5.21	6	0.0
November----	54.0	35.4	44.7	76	18	168	3.94	1.96	5.65	7	0.9
December----	41.8	26.4	34.1	65	6	43	4.23	2.20	6.01	8	6.4
Yearly:											
Average---	63.1	42.6	52.9	---	---	---	---	---	---	---	---
Extreme---	---	---	---	100	-3	---	---	---	---	---	---
Total-----	---	---	---	---	---	5,637	48.15	56.03	84.0	84	30.7

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

Table 2.--Freeze Dates in Spring and Fall

(Recorded in the period 1951-78 at Plainfield, New Jersey)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 5	April 19	May 8
2 years in 10 later than--	March 31	April 15	May 3
5 years in 10 later than--	March 24	April 8	April 22
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 31	Oct. 16	Oct. 3
2 years in 10 earlier than--	Nov. 5	Oct. 21	Oct. 8
5 years in 10 earlier than--	Nov. 15	Oct. 30	Oct. 17

Table 3.--Growing Season

(Recorded in the period 1951-78 at Plainfield, New Jersey)

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	216	189	156
8 years in 10	223	194	164
5 years in 10	236	204	178
2 years in 10	248	213	191
1 year in 10	255	218	199

Table 4.--Acreage and Proportionate Extent of the Soils

Map symbol	Soil name	Acres	Percent
AmhB	Amwell silt loam, 3 to 8 percent slopes	1,130	1.7
AmhCb	Amwell silt loam, 8 to 15 percent slopes, very stony	110	0.2
AmuB	Amwell-Urban land complex, 0 to 8 percent slopes	1,650	2.4
BhnB	Birdsboro silt loam, 3 to 8 percent slopes	240	0.4
BhpB	Birdsboro-Urban land complex, 0 to 8 percent slopes	3,300	4.9
BogB	Boonton loam, 3 to 8 percent slopes	1,350	2.0
BohC	Boonton gravelly loam, 8 to 15 percent slopes	450	0.7
BohD	Boonton gravelly loam, 15 to 25 percent slopes	360	0.5
BovB	Boonton-Urban land-Haledon complex, 0 to 8 percent slopes	15,200	22.5
BouD	Boonton-Urban land complex, 15 to 25 percent slopes	1,700	2.5
Cara	Carlisle-Adrian mucks	530	0.8
DunB	Dunellen sandy loam, 3 to 8 percent slopes	230	0.3
DuuA	Dunellen-Urban land complex, 0 to 3 percent slopes	580	0.9
DuuB	Dunellen-Urban land complex, 3 to 8 percent slopes	560	0.8
DuuD	Dunellen-Urban land complex, 15 to 25 percent slopes	120	0.2
Fmt	Fluvaquents, frequently flooded	1,200	1.8
HakA	Haledon loam, 0 to 3 percent slopes	590	0.9
HakB	Haledon loam, 3 to 8 percent slopes	820	1.2
HatB	Haledon-Urban land-Hasbrouck complex, 0 to 8 percent slopes	9,340	13.8
HctA	Hasbrouck silt loam, 0 to 3 percent slopes	420	0.6
NehBc	Neshaminy silt loam, 0 to 8 percent slopes, extremely stony	440	0.7
NehCc	Neshaminy silt loam, 8 to 15 percent slopes, extremely stony	140	0.2
NehDc	Neshaminy silt loam, 15 to 25 percent slopes, extremely stony	130	0.2
NehFc	Neshaminy silt loam, 25 to 45 percent slopes, extremely stony	340	0.5
NenB	Neshaminy-Urban land complex, 0 to 8 percent slopes	680	1.0
NenD	Neshaminy-Urban land complex, 15 to 25 percent slopes	480	0.7
Pbp	Parsippany silt loam	260	0.4
Pbs	Parsippany-Urban land complex, 0 to 3 percent slopes	810	1.2
Pcs	Passaic silt loam	590	0.9
RarA	Raritan silt loam, 0 to 3 percent slopes	310	0.5
RasA	Raritan-Urban land-Passaic complex, 0 to 3 percent slopes	1,450	2.1
SUCT	Sulfihemists and Sulfaquents, frequently flooded	530	0.8
TunE	Tunkhannock gravelly loam, 25 to 45 percent slopes	190	0.3
Ucd	Udifluvents, frequently flooded	220	0.3
Udh	Udorthents, loamy	1,500	2.2
Udy	Udorthents, organic substratum	2,400	3.6
Udz	Udorthents, refuse substratum	700	1.0
UR	Urban land	13,500	20.0
WATER	Water	1,400	2.1
WhpA	Whippany silt loam, 0 to 3 percent slopes	140	0.2
WhpB	Whippany silt loam, 3 to 8 percent slopes	160	0.2
WhrB	Whippany-Urban land complex, 0 to 8 percent slopes	1,250	1.9
	Total	67,500	100.0

Table 5.--Prime Farmland

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parenthesis after the soil name)

Map Symbol	Soil name
BhnB	Birdsboro silt loam, 3 to 8 percent slopes
BogB	Boonton loam, 3 to 8 percent slopes
DunB	Dunellen sandy loam, 3 to 8 percent slopes
HakA	Haledon loam, 0 to 3 percent slopes
HakB	Haledon loam, 3 to 8 percent slopes
RarA	Raritan silt loam, 0 to 3 percent slopes
WhpA	Whippany silt loam, 0 to 3 percent slopes
WhrB	Whippany silt loam, 3 to 8 percent slopes

Table 6.--Woodland Management and Productivity

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Productivity class*	Trees to plant
AmhB, AmhCo----- Amwell	4W	Slight	Slight	Slight	Slight	Northern red oak---- Red maple----------- White Ash----------- White Oak----------- Yellow popular------ Shagbark hickory----	80 80 80 80 90 80	4 4 4 4 6 4	Eastern white pine, Red oak Yellow popular.
AmuB**: Amwell---------	4W	Slight	Slight	Slight	Slight	Northern red oak---- Yellow poplar------- White oak----------- White ash----------- Red maple----------- Shagbark hickory----	80 90 80 80 80 80	4 6 4 4 4 4	Eastern white pine, Red oak, Yellow poplar.
Urban land.									
BhnB------------ Birdsboro	4A	Slight	Slight	Slight	Slight	Northern red oak---- Yellow poplar------- Chestnut oak-------- Sugar maple---------	80 90 60 80	4 6 3 4	Eastern white pine, Red oak Yellow poplar, Sugar maple.
BhpB**: Birdsboro------	4A	Slight	Slight	Slight	Slight	Northern red oak---- Yellow poplar------- Chestnut oak-------- Sugar maple---------	80 90 60 80	4 6 3 4	Eastern white pine, Red oak, Yellow poplar, Sugar maple.
Urban land.									
BogB, BohC------ Boonton	4D	Slight	Slight	Slight	Moderate	Northern red oak---- White ash----------- Yellow poplar------- White oak-----------	80 95 90 80	4 4 6 4	Eastern white pine, Red oak, Yellow poplar Wnite ash.
BohD------------ Boonton	4R	Moderate	Moderate	Slight	Moderate	Northern red oak---- White ash----------- Yellow poplar------- Chestnut oak-------- White oak-----------	80 95 90 60 80	4 4 6 3 4	Eastern white pine, Red oak, Yellow poplar.
BovB**: Boonton--------	4D	Slight	Slight	Slignt	Moderate	Northern red oak---- White ash----------- Yellow poplar------- White oak-----------	80 95 90 80	4 4 6 4	Eastern white pine, Red oak, White ash.
Urban land.									
Haledon--------	4W	Slight	Moderate	Moderate	Moderate	Pin oak------------- White oak----------- White ash----------- Red maple----------- Sweet gum-----------	70 70 --- --- ---	4 4 -- -- --	Eastern white pine, White oak, White ash, Red Maple.

See footnote at end of table.

Table 6.--Woodland Management and Productivity--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Productivity class*	Trees to plant
BouD**:									
Boonton	4R	Moderate	Moderate	Slight	Moderate	Northern red oak	80	4	Eastern white pine, Red oak, White ash.
						White ash	95	4	
						Yellow poplar	90	6	
						Chestnut oak	60	3	
						White oak	70	4	
Urban land.									
Cara**:									
Carlisle	2W	Slight	Severe	Severe	Severe	Red maple	56	3	Sweet gum, Green ash, Red maple, Pin oak.
						White ash	---	--	
						Sweet gum	---	--	
						Pin oak	---	--	
						Swamp white oak	---	--	
						Silver maple	82	2	
Adrian	2W	Slight	Severe	Severe	Severe	Red maple	51	2	Sweet gum, Red maple, Pin oak.
						Silver maple	76	2	
						White ash	51	2	
						Sweet gum	--	4	
						River birch	45	2	
						Pin oak	60	3	
						Northern whitecedar	27	3	
DunB Dunellen	4A	Slight	Slight	Slight	Slight	Northern red oak	80	4	Eastern white pine, Yellow poplar, Black walnut, Red oak, White oak.
						Black oak	80	4	
						White oak	80	4	
						Sugar maple	80	4	
						White ash	85	4	
						Yellow poplar	---	--	
						Chestnut oak	60	3	
DuuA**:									
Dunellen	4A	Slight	Slight	Slight	Slight	Northern red oak	80	4	Eastern white pine, Yellow poplar, Red oak, White oak, Sugar maple.
						Black oak	80	4	
						White oak	80	4	
						Sugar maple	80	4	
						White ash	85	4	
						Yellow poplar	80	5	
						Chestnut oak	60	3	
Urban land.									
DuuB**:									
Dunellen	4A	Slight	Slight	Slight	Slight	Northern red oak	80	4	Eastern white pine, Yellow poplar, Black walnut, Red oak, White oak, Sugar Maple.
						Black oak	80	4	
						White oak	80	4	
						Sugar maple	80	4	
						White ash	85	4	
						Yellow poplar	---	--	
						Chestnut oak	60	3	
Urban land.									

See footnote at end of table.

Table 6.--Woodland Management and Productivity--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Productivity class*	Trees to plant
DuuD**:									
Dunellen	4R	Severe	Severe	Moderate	Moderate	Northern red oak	80	4	Eastern white pine, Yellow poplar, Black walnut, Red oak, White oak, Sugar maple.
						Black oak	80	4	
						White oak	80	4	
						Sugar maple	80	4	
						White ash	85	4	
						Yellow poplar	---	--	
						Chestnut oak	60	3	
Urban land.									
Fmt: Fluvaquents	5W	Slight	Severe	Severe	Moderate	Pin oak	85	5	
						Sweet gum	80	4	
						Red maple	60	3	
HakA, HakB: Haledon	4W	Slight	Moderate	Moderate	Moderate	Pin oak	70	4	Eastern white pine, White oak, White ash, Pin oak, Red maple.
						White oak	70	4	
						White ash	---	--	
						Red maple	---	--	
						Sweet gum			
HatB**:									
Haledon	4W	Slight	Moderate	Moderate	Moderate	Pin oak	70	4	Eastern white pine, White oak, White ash, Pin oak, Red maple.
						White oak	70	4	
						White ash	---	--	
						Red maple	---	--	
						Sweet gum	---	--	
Urban land.									
Hasbrouck	3W	Slight	Severe	Severe	Moderate	Red maple	75	3	Eastern white pine, Sweet gum, Red maple, Pin oak.
						Pin oak	---	--	
						White oak	---	--	
						Swamp white oak	---	--	
						Sweet gum	75	3	
HctA: Hasbrouck	3W	Slight	Severe	Severe	Moderate	Red maple	75	3	Eastern white pine, Sweet gum, Red maple, Pin oak.
						Pin oak	---	--	
						White oak	---	--	
						Swamp white oak	---	--	
						Sweet oak	75	3	
NehBc, NehCc, NehDc Neshaminy	4X	Slight	Moderate	Slight	Slight	Northern red oak	80	4	Eastern white pine, yellow poplar, black walnut, White oak, Red oak, Hickory.
						Yellow poplar	90	6	
						White oak	80	4	
						Sugar maple	80	4	
						Chestnut oak	60	3	
						Bitternut hickory	80	4	
NehFc: Neshaminy	4R	Moderate	Severe	Slight	Slight	Northern red oak	80	4	Eastern white pine, Yellow poplar, Black walnut, Virginia pine, Norway spruce, Japanese larch.
						Yellow poplar	90	6	
						White oak	80	4	
						Sugar maple	80	4	
						Chestnut oak	60	3	
						Bitternut hickory	80	4	

See footnote at end of table.

Table 6.--Woodland Management and Productivity--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Productivity class*	Trees to plant
NenB**, NenD**:									
Neshaminy	4X	Slight	Moderate	Slight	Slight	Northern red oak	80	4	Eastern white pine, Yellow poplar, Black walnut, White oak, Red oak, Hickory.
						Yellow poplar	90	6	
						White oak	80	4	
						Sugar maple	80	4	
						Chestnut oak	60	3	
						Bitternut hickory	80	4	
Urban land.									
Pbp: Parsippany	3W	Slight	Severe	Severe	Severe	Northern red oak	60	3	Red maple, Sweet gum, Pin oak.
						Red maple	65	3	
						Sweet gum	60	3	
						Pin oak	60	3	
						Shagbark hickory	60	3	
Pbs**:									
Parsippany	3W	Slight	Severe	Severe	Severe	Sweet gum	---	--	Eastern white pine, White spruce.
						Red maple	65	3	
						Pin oak	60	3	
						Shagbark hickory	60	3	
Urban land.									
Pcs: Passaic	3W	Slight	Severe	Severe	Severe	Sweet gum	60	3	Red maple, Sweet gum, Pin oak.
						Red maple	60	3	
						Pin oak	60	3	
RarA: Raritan	4A	Slight	Moderate	Slight	Slight	White ash	60	3	Eastern white pine, Yellow poplar, Sweet gum, Pin oak, Red maple.
						Yellow poplar	80	5	
						Sweet gum	60	3	
						Red maple	51	2	
						White oak	80	4	
						Shagbark hickory	80	4	
RasA**:									
Raritan	4A	Slight	Moderate	Slight	Slight	White ash	60	3	Eastern white pine, Yellow poplar, Sweet gum, Red maple, Pin oak.
						Yellow poplar	80	5	
						Sweet gum	60	3	
						Red maple	51	2	
						White oak	80	4	
						Shagbark hickory	80	4	
Urban land.									
Passaic	3W	Slight	Severe	Severe	Severe	Sweet gum	60	3	
						Red maple	60	3	
						Pin oak	60	3	
TunE: Tunkhannock	4R	Slight	Moderate	Slight	Slight	Northern red oak	70	4	Eastern white pine, Red oak, White oak, Sugar maple.
						Sugar maple	65	3	
						White oak	70	4	
						Bitternut hickory	70	4	
						American beech	70	4	

See footnote at end of table.

Table 6.--Woodland Management and Productivity--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Productivity class*	Trees to plant
WhpA, WhpB------ Whippany	4W	Slight	Slight	Slight	Slight	Red maple----------- Yellow poplar------- White ash----------- White oak----------- Pin oak-------------	80 90 --- 80 80	4 6 -- 4 4	Eastern white pine, White oak, Yellow poplar, Pin oak.
WhrB**:									
Whippany-------	4W	Slight	Slight	Slight	Slight	Red maple----------- Yellow poplar------- White ash----------- White oak----------- Pin oak-------------	80 90 --- 80 80	4 6 -- 4 4	Eastern white pine, White oak, Yellow poplar, Pin oak.
Urban land.									

* Productivity class is the yield in cubic meters per hectare per year calculated at the age of culmination of mean annual increment for fully stocked natural stands.

** See description of the map unit for composition and behavior characteristics of the map unit.

Table 7.--Recreational Development

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
AmhB------------------- Amwell	Severe: wetness.	Moderate: wetness, small stones.	Severe: small stones, wetness.	Moderate: wetness.	Moderate: small stones, large stones.
AmhCb------------------ Amwell	Severe: wetness.	Moderate: slope, wetness, large stones.	Severe: large stones, slope, small stones.	Moderate: wetness.	Moderate: small stones, large stones.
AmuB*:					
Amwell---------------	Severe: wetness.	Moderate: slope, wetness, small stones.	Severe: slope, small stones, wetness.	Moderate: wetness.	Moderate: small stones, large stones, slope.
Urban land-----------	Variable--------	Variable--------	Variable--------	Variable--------	Variable.
BhnB------------------ Birdsboro	Severe: flooding.	Moderate: wetness.	Moderate: slope, small stones.	Severe: erodes easily.	Slight.
BhpB:					
Birdsboro------------	Severe: flooding.	Moderate: wetness.	Moderate: slope, small stones.	Severe: erodes easily.	Slight.
Urban land-----------	Variable--------	Variable--------	Variable--------	Variable--------	Variable.
BogB------------------ Boonton	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Severe: erodes easily.	Moderate: wetness.
BohC------------------ Boonton	Severe: percs slowly.	Severe: percs slowly.	Severe: slope, small stones, percs slowly.	Severe: erodes easily.	Moderate: small stones, wetness, slope.
BohD------------------ Boonton	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, small stones, percs slowly.	Severe: slope, erodes easily.	Severe: slope.
BovB*:					
Boonton--------------	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Severe: erodes easily.	Moderate: wetness.
Urban land-----------	Variable--------	Variable--------	Variable--------	Variable--------	Variable.
Haledon--------------	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

See footnote at end of table.

Table 7.--Recreational Development--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
BouD*:					
Boonton	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, small stones, percs slowly.	Severe: erodes easily.	Severe: slope.
Urban land	Variable	Variable	Variable	Variable	Variable.
Cara*:					
Carlisle	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: excess humus, ponding, flooding.	Severe: ponding, excess humus.	Severe: ponding, flooding, excess humus.
Adrian	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: flooding, ponding, excess humus.	Severe: ponding, excess humus.	Severe: flooding, ponding, excess humus.
DunB: Dunellen	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
DuuA*:					
Dunellen	Slight	Slight	Moderate: small stones.	Slight	Slignt.
Urban land	Variable	Variable	Variable	Variable	Variable.
DuuB*:					
Dunellen	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Urban land	Variable	Variable	Variable	Variable	Variable.
DuuD*:					
Dunellen	Severe: slope.	Severe: slope.	Severe: slope.	----------------	Severe: slope.
Urban land	Variable	Variable	Variable	Variable	Variable.
Fmt: Fluvaquents	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
HakA, HakB: Haledon	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
HatB*:					
Haledon	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Urban land	Variable	Variable	Variable	Variable	Variable.
Hasbrouck	Severe: flooding, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.

See footnote at end of table.

Table 7.--Recreational Development--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
HctA: Hasbrouck	Severe: flooding, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
NehBc: Neshaminy	Severe: large stones.	Severe: large stones.	Severe: large stones, small stones.	Slight	Moderate: small stones, large stones.
NehCc: Neshaminy	Severe: large stones.	Severe: large stones.	Severe: large stones, slope, small stones.	Slight	Moderate: small stones, large stones, slope.
NehDc: Neshaminy	Severe: slope, large stones.	Severe: slope, large stones.	Severe: large stones, slope, small stones.	Moderate: slope.	Severe: slope.
NehFc: Neshaminy	Severe: slope, large stones.	Severe: slope, large stones.	Severe: large stones, slope, small stones.	Severe: slope.	Severe: slope.
NenB*:					
Neshaminy	Severe: large stones.	Severe: large stones.	Severe: large stones, slope, small stones.	Slight	Moderate: small stones, large stones, slope.
Urban land	Variable	Variable	Variable	Variable	Variable.
NenD*:					
Neshaminy	Severe: slope, large stones.	Severe: slope, large stones.	Severe: large stones, slope, small stones.	Moderate: slope.	Severe: slope.
Urban land	Variable	Variable	Variable	Variable	Variable.
Pbp: Parsippany	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, erodes easily.	Severe: wetness.
Pbs*:					
Parsippany	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, erodes easily.	Severe: wetness.
Urban land	Variable	Variable	Variable	Variable	Variable.
Pcs: Passaic	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

See footnote at end of table.

Table 7.--Recreational Development--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
RarA: Raritan	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, erodes easily.	Severe: wetness.
RasA*:					
Raritan	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, erodes easily.	Severe: wetness.
Urban land	Variable	Variable	Variable	Variable	Variable.
Passaic	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
SUCT*:					
Sulfihemists	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness.
Sulfaquents	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness.
TunE: Tunkhannock	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope, small stones.	Severe: slope.	Severe: small stones, slope.
Ucd. Udifluvents	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Udn, Udy, Udz. Udorthents	Variable	Variable	Variable	Variable	Variable.
UR*: Urban land	Variable	Variable	Variable	Variable	Variable.
WhpA, WhpB: Whippany	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, erodes easily.	Severe: wetness.
WnrB*:					
Whippany	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, erodes easily.	Severe: wetness.
Urban land	Variable	Variable	Variable	Variable	Variable.

* See description of the map unit for composition and behavior characteristics of the map unit.

Table 8.--Wildlife Habitat

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
AmhB---------------- Amwell	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
AmhCb--------------- Amwell	Very poor.	Poor	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
AmuB*:										
Amwell-------------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Urban land.										
BhnB---------------- Birdsboro	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
BhpB*:										
Birdsboro----------	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Urban land.										
BogB---------------- Boonton	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
BohC---------------- Boonton	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
BohD---------------- Boonton	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
BouD*:										
Boonton------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Urban land.										
Haledon------------	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
BovB*:										
Boonton------------	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Urban land.										

See footnote at end of table.

Table 8.--Wildlife Habitat--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
Cara*:										
Carlisle	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Adrian	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
DunB-- Dunellen	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
DuuA*:										
Dunellen	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Urban land.										
DuuB*:										
Dunellen	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Urban land.										
DuuD*:										
Dunellen	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Urban land.										
Fmt Fluvaquents	Poor	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair.
HakA Haledon	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
HakB Haledon	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
HatB*:										
Haledon	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Urban land.										
Hasbrouck	Poor	Fair	Good	Fair	Fair	Good	Good	Fair	Fair	Good.
HctA Hasbrouck	Poor	Fair	Good	Fair	Fair	Good	Good	Fair	Fair	Good.
NehBc Neshaminy	Very poor.	Very poor.	Good	Good	Good	Poor	Very poor.	Poor	Good	Very poor.
NehCc, NehDc, NehFc Neshaminy	Very poor.	Very poor.	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
NenB*, NenD*:										
Neshaminy	Very poor.	Very poor.	Good	Good	Good	Very poor.	Very poor.	Poor	Good	Very poor.
Urban land.										

See footnote at end of table.

Table 8.--Wildlife Habitat--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
Pbp---------------- Parsippany	Poor	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Pbs*:										
Parsippany--------	Poor	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
Urban land.										
Pcs---------------- Passaic	Poor	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
RarA--------------- Raritan	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
RasA*:										
Raritan-----------	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Urban land.										
Passaic-----------	Poor	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
SUCT*:										
Sulfihemists.										
Sulfaquents.										
TunE--------------- Tunkhannock	Very poor.	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Ucd. Udifluvents										
Udh, Udy, Udz. Udorthents										
UR*: Urban land.										
WhpA--------------- Whippany	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
WhpB--------------- Whippany	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
WhrB*:										
Whippany----------	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Urban land.										

* See description of the map unit for composition and behavior characteristics of the map unit.

Table 9.--Building Site Development

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
AmhB: Amwell	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: small stones, large stones.
AmhCb: Amwell	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, slope.	Severe: frost action.	Moderate: small stones, large stones.
AmuB*:						
Amwell	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, slope.	Severe: frost action.	Moderate: small stones, large stones, slope.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable.
BhnB: Birdsboro	Severe: cutbanks cave, wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Moderate: low strength, wetness.	Slight.
BhpB*:						
Birdsboro	Severe: cutbanks cave, wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Moderate: low strength, wetness.	Slight.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable.
BogB: Boonton	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness, slope.	Moderate: wetness, frost action.	Moderate: wetness.
BohC: Boonton	Severe: wetness.	Moderate: wetness, slope.	Severe: wetness.	Severe: slope.	Moderate: wetness, slope, frost action.	Moderate: small stones, wetness, slope.
BohD: Boonton	Severe: wetness, slope.	Severe: slope.	Severe: wetness, slope.	Severe: slope.	Severe: slope.	Severe: slope.
BovB*:						
Boonton	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness, slope.	Moderate: wetness, frost action.	Moderate: wetness.

See footnote at end of table.

Table 9.--Building Site Development--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
BovB*:						
Urban land	Variable	Variable	Variable	Variable	Variable	Variable.
Haledon	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
BouD*:						
Boonton	Severe: wetness, slope.	Severe: slope.	Severe: wetness, slope.	Severe: slope.	Severe: slope.	Severe: slope.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable.
Cara*:						
Carlisle	Severe: excess humus, ponding.	Severe: flooding, ponding, subsides.	Severe: flooding, ponding, subsides.	Severe: flooding, ponding, subsides.	Severe: ponding, flooding, subsides.	Severe: ponding, flooding, excess humus.
Adrian	Severe: cutbanks cave, ponding, excess humus.	Severe: subsides, flooding, ponding.	Severe: subsides, flooding, ponding.	Severe: subsides, flooding, ponding.	Severe: subsides, flooding, ponding.	Severe: flooding, ponding, excess humus.
DunB: Dunellen	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
DuuA*:						
Dunellen	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Moderate: frost action.	Slight.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable.
DuuB*:						
Dunellen	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable.
DuuD*:						
Dunellen	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable.
Fmt: Fluvaquents	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding, frost action.	Severe: wetness, flooding.
HakA, HakB: Haledon	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
HatB*:						
Haledon	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.

See footnote at end of table.

Table 9.--Building Site Development--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
HatB*:						
Urban land	Variable	Variable	Variable	Variable	Variable	Variable.
Hasbrouck	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, frost action.	Severe: wetness.
HctA: Hasbrouck	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, frost action.	Severe: wetness.
NehBc: Neshaminy	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope.	Moderate: frost action.	Severe: small stones, large stones.
NehCc: Neshaminy	Moderate: depth to rock, slope.	Moderate: slope.	Moderate: depth to rock, slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: small stones, large stones, slope.
NehDc, NehFc: Neshaminy	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
NenB*:						
Neshaminy	Moderate: depth to rock, slope.	Moderate: slope.	Moderate: depth to rock, slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: small stones, large stones, slope.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable.
NenD*:						
Neshaminy	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable.
Pbp: Parsippany	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness.
Pbs*:						
Parsippany	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable.
Pcs: Passaic	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.	Severe: wetness.

See footnote at end of table.

Table 9.--Building Site Development--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
RarA: Raritan	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, frost action.	Severe: wetness.
RasA*:						
Raritan	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, frost action.	Severe: wetness.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable.
Passaic	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.	Severe: wetness.
SUCT*:						
Sulfihemists	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.
Sulfaquents	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness. flooding.	Severe: wetness, flooding.
TunE: Tunkhannock	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: small stones, slope.
Ucd. Udifluvents	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Udh, Udy, Udz. Udorthents	Variable	Variable	Variable	Variable	Variable	Variable.
UR*: Urban land.	Variable	Variable	Variable	Variable	Variable	Variable.
WhpA, WhpB: Whippany	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, frost action.	Severe: wetness.
WhrB*:						
Whippany	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, frost action.	Severe: wetness.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable.

* See description of the map unit for composition and behavior characteristics of the map unit.

Table 10.--Sanitary Facilities

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
AmhB---------------- Amwell	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: small stones, wetness.
AmhCb--------------- Amwell	Severe: wetness, percs slowly.	Severe: seepage, slope, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: small stones, wetness.
AmuB*:					
Amwell--------------	Severe: wetness, percs slowly.	Severe: seepage, slope, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: small stones, wetness.
Urban land---------	Variable---------	Variable---------	Variable---------	Variable---------	Variable.
BhnB---------------- Birdsboro	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Fair: too clayey, small stones.
BhpB*:					
Birdsboro----------	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Fair: too clayey, small stones.
Urban land---------	Variable---------	Variable---------	Variable---------	Variable---------	Variable.
BogB---------------- Boonton	Severe: wetness, percs slowly.	Moderate: seepage, slope.	Severe: wetness.	Moderate: wetness.	Poor: small stones.
BohC---------------- Boonton	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness.	Moderate: wetness, slope.	Poor: small stones.
BohD---------------- Boonton	Severe: wetness, percs slowly, slope.	Severe: slope.	Severe: wetness, slope.	Severe: slope.	Poor: small stones, slope.
BovB*:					
Boonton------------	Severe: wetness, percs slowly.	Moderate: seepage, slope.	Severe: wetness.	Moderate: wetness.	Poor: small stones.
Urban land---------	Variable---------	Variable---------	Variable---------	Variable---------	Variable.

See footnote at end of table.

Table 10.--Sanitary Facilities--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
BovB*:					
Haledon	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
BouD*:					
Boonton	Severe: wetness, percs slowly, slope.	Severe: slope.	Severe: wetness, slope.	Severe: slope.	Poor: small stones, slope.
Urban land	Variable	Variable	Variable	Variable	Variable.
Cara*:					
Carlisle	Severe: flooding, ponding, subsides.	Severe: seepage, flooding, excess humus.	Severe: flooding, seepage, ponding.	Severe: flooding, seepage, ponding.	Poor: ponding, excess humus.
Adrian	Severe: subsides, flooding, ponding.	Severe: seepage, flooding, excess humus.	Severe: seepage, flooding, ponding.	Severe: seepage, flooding, ponding.	Poor: ponding, too sandy, seepage.
DunB Dunellen	Moderate: percs slowly.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: small stones, thin layer.
DuuA*:					
Dunellen	Moderate: wetness, percs slowly.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: small stones, thin layer.
Urban land	Variable	Variable	Variable	Variable	Variable.
DuuB*:					
Dunellen	Moderate: percs slowly, slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: small stones, slope, thin layer.
Urban land	Variable	Variable	Variable	Variable	Variable.
DuuD*:					
Dunellen	Severe: slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: slope.
Urban land	Variable	Variable	Variable	Variable	Variable.
Fmt Fluvaquents	Severe: flooding, wetness, percs slowly.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
HakA, HakB Haledon	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

See footnote at end of table.

Table 10.--Sanitary Facilities--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
HatB*:					
Haledon	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Urban land	Variable	Variable	Variable	Variable	Variable.
Hasbrouck	Severe: wetness, percs slowly.	Severe: seepage.	Severe: seepage, wetness.	Severe: wetness.	Poor: wetness.
HctA: Hasbrouck	Severe: wetness, percs slowly.	Severe: seepage.	Severe: seepage, wetness.	Severe: wetness.	Poor: wetness.
NehBc: Neshaminy	Severe: percs slowly.	Moderate: depth to rock, slope.	Severe: depth to rock.	Moderate: depth to rock.	Poor: hard to pack, small stones.
NehCc: Neshaminy	Severe: percs slowly.	Severe: slope.	Severe: depth to rock.	Moderate: depth to rock, slope.	Poor: hard to pack, small stones.
NehDc, NehFc: Neshaminy	Severe: percs slowly, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Poor: hard to pack, small stones, slope.
NenB*:					
Neshaminy	Severe: percs slowly.	Severe: slope.	Severe: depth to rock.	Moderate: depth to rock, slope.	Poor: hard to pack, small stones.
Urban land	Variable	Variable	Variable	Variable	Variable.
NenD*:					
Neshaminy	Severe: percs slowly, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Poor: hard to pack, small stones, slope.
Urban land	Variable	Variable	Variable	Variable	Variable.
Pbp: Parsippany	Severe: flooding, wetness, percs slowly.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
Pbs*:					
Parsippany	Severe: flooding, wetness, percs slowly.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: wetness.
Urban land	Variable	Variable	Variable	Variable	Variable.

See footnote at end of table.

Table 10.--Sanitary Facilities--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Pcs----------------- Passaic	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, small stones, wetness.
RarA---------------- Raritan	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Poor: wetness.
RasA*:					
Raritan------------	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: wetness.	Poor: wetness.
Urban land---------	Variable---------	Variable---------	Variable---------	Variable---------	Variable.
Passaic------------	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: too sandy, small stones, wetness.
SUCT*:					
Sulfihemists--------	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness flooding.
Sulfaquents--------	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.
TunE---------------- Tunkhannock	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Ucd. Udifluvents--------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Udh, Udy, Udz. Udorthents---------	Variable---------	Variable --------	Variable---------	Variable---------	Variable.
UR*----------------- Urban land	Variable---------	Variable---------	Variable---------	Variable---------	Variable.
WhpA, WhpB---------- Whippany	Severe: wetness, percs slowly.	Severe: flooding, wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
WhrB*:					
Whippany-----------	Severe: wetness, percs slowly.	Severe: flooding, wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Urban land---------	Variable---------	Variable---------	Variable---------	Variable---------	Variable.

* See description of the map unit for composition and behavior characteristics of the map unit.

Table 11.--Construction Materials

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
AmhB, AmhCb----------- Amwell	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
AmuB*:				
Amwell----------------	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
Urban land-----------	Variable------------	Variable-------------	Variable-------------	Variable.
BhnB----------------- Birdsboro	Fair: wetness.	Probable-------------	Probable ------------	Poor: small stones, area reclaim.
BhpB*:				
Birdsboro------------	Fair: wetness.	Probable-------------	Probable-------------	Poor: small stones, area reclaim.
Urban land-----------	Variable-------------	Variable-------------	Variable-------------	Variable.
BogB, BohC------------ Boonton	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
BohD------------------ Boonton	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim, slope.
BovB*:				
Boonton---------------	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
Urban land-----------	Variable-------------	Variable-------------	Variable-------------	Variable.
Haledon--------------	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, area reclaim, wetness.

See footnote at end of table.

Table 11.--Construction Materials--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
BouD*:				
Boonton	Fair: wetness, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim, slope.
Urban land	Variable	Variable	Variable	Variable.
Cara*:				
Carlisle	Poor: wetness, low strength.	Improbable: excess humus.	Improbable: excess humus.	Poor: excess humus, wetness.
Adrian	Poor: wetness.	Probable	Improbable: too sandy.	Poor: excess humus, wetness.
DunB Dunellen	Good	Probable	Probable	Poor: small stones, area reclaim.
DuuA*, DuuB*:				
Dunellen	Good	Probable	Probable	Poor: small stones, area reclaim.
Urban land	Variable	Variable	Variable	Variable.
DuuD*:				
Dunellen	Fair-Poor: Slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
Urban land	Variable	Variable	Variable	Variable.
Fmt Fluvaquents	Poor: wetness, low strength.	Poor: excess fines.	Poor: excess fines.	Poor: area reclaim, wetness.
HakA, HakB Haledon	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, area reclaim, wetness.
HatB*:				
Haledon	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: large stones, area reclaim, wetness.
Urban land	Variable	Variable	Variable	Variable.
Hasbrouck	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.
HctA Hasbrouck	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.

See footnote at end of table.

Table 11.--Construction Materials--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
NehBc, NenCc: Neshaminy	Fair: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
NehDc: Neshaminy	Fair: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim, slope.
NehFc: Neshaminy	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim, slope.
NenB*:				
Neshaminy	Fair: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim.
Urban land	Variable	Variable	Variable	Variable.
NenD*:				
Neshaminy	Fair: area reclaim, thin layer, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, area reclaim, slope.
Urban land	Variable	Variable	Variable	Variable.
Pbp: Parsippany	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Pbs*:				
Parsippany	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Urban land	Variable	Variable	Variable	Variable.
Pcs: Passaic	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, area reclaim, wetness.
RarA: Raritan	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, wetness.
RasA*:				
Raritan	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, wetness.
Urban land	Variable	Variable	Variable	Variable.

See footnote at end of table.

Table 11.--Construction Materials--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
RasA*:				
Passaic	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, area reclaim, wetness.
SUCT*:				
Sulfihemists	Poor: wetness.	Variable	Variable	Poor: wetness.
Sulfaquents	Poor: wetness.	Variable	Variable	Poor: wetness.
TunE Tunkhannock	Poor: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
Ucd. Udifluvents	Variable	Variable	Variable	Variable.
Udh, Udy, Udz. Udorthents	Variable	Variable	Variable	Variable.
UR* Urban land.	Variable	Variable	Variable	Variable.
WhpA, WhpB Whippany	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
WhrB*:				
Whippany	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
Urban land	Variable	Variable	Variable	Variable.

* See description of the map unit for composition and behavior characteristics of the map unit.

Table 12.--Water Management

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
AmhB: Amwell	Severe: seepage.	Severe: piping.	Severe: no water.	Percs slowly, frost action, slope.	Wetness, percs slowly, rooting depth.	Wetness, rooting depth.	Wetness, rooting depth.
AmhCb: Amwell	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Percs slowly, frost action, slope.	Wetness, percs slowly, rooting depth.	Slope, wetness, rooting depth.	Wetness, slope, rooting depth.
AmuB*:							
Amwell	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Percs slowly, frost action, slope.	Wetness, percs slowly, rooting depth.	Slope, wetness, rooting depth.	Wetness, slope, rooting depth.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
BhnB: Birdsboro	Moderate: seepage, slope.	Severe: piping.	Severe: cutbanks cave.	Slope	Slope, wetness, erodes easily.	Slope, wetness, erodes easily.	Favorable.
BhpB*:							
Birdsboro	Moderate: seepage, slope.	Severe: piping.	Severe: cutbanks cave.	Slope	Slope, wetness, erodes easily.	Slope, wetness, erodes easily.	
Urban land	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
BogB: Boonton	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Percs slowly, slope.	Slope, wetness, droughty.	Erodes easily, wetness.	Erodes easily, droughty.
BohC, BohD: Boonton	Severe: slope.	Severe: piping.	Severe: no water.	Percs slowly, slope.	Slope, wetness, droughty.	Slope, erodes easily, wetness.	Slope, erodes easily, droughty.
BovB*:							
Boonton	Moderate: seepage, slope.	Severe: piping.	Severe: no water.	Percs slowly, slope.	Slope, wetness, droughty.	Erodes easily, wetness.	Erodes easily, droughty.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
Haledon	Moderate: seepage.	Severe: piping, wetness.	Severe: no water.	Percs slowly, frost action.	Wetness, percs slowly, rooting depth.	Large stones, erodes easily.	Large stones, wetness.

See footnote at end of table.

Table 12.--Water Management--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
BouD*:							
Boonton	Severe: slope.	Severe: piping.	Severe: no water.	Percs slowly, slope.	Slope, wetness, droughty.	Slope, erodes easily, wetness.	Slope, erodes easily, droughty.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
Cara*:							
Carlisle	Severe: seepage.	Severe: excess humus, ponding.	Severe: slow refill.	Ponding, flooding, subsides.	Ponding, soil blowing, flooding.	Ponding, soil blowing.	Wetness.
Adrian	Severe: seepage.	Severe: ponding, piping, seepage.	Severe: cutbanks cave, slow refill.	Ponding, flooding, subsides.	Flooding, ponding, soil blowing.	Ponding, too sandy, soil blowing.	Wetness.
DunB: Dunellen	Severe: seepage.	Severe: piping.	Severe: no water.	Deep to water	Slope	Favorable	Favorable.
DuuA*:							
Dunellen	Severe: seepage.	Severe: piping.	Severe: cutbanks cave.	Deep to water	Favorable	Favorable	Favorable.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
DuuB*, DuuD*:							
Dunellen	Severe: seepage, slope.	Severe: piping.	Severe: no water.	Deep to water	Slope	Slope	Slope.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
Fmt: Fluvaquents	Moderate: seepage.	Severe: piping, wetness.	Severe: slow refill, cutbanks cave.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
HakA: Haledon	Moderate: seepage.	Severe: piping, wetness.	Severe: no water.	Percs slowly, frost action.	Wetness, percs slowly, rooting depth.	Large stones, erodes easily.	Large stones, wetness.
HakB: Haledon	Moderate: seepage, slope.	Severe: piping, wetness.	Severe: no water.	Percs slowly, frost action, slope.	Wetness, percs slowly, rooting depth.	Large stones, erodes easily.	Large stones, wetness.
HatB*:							
Haledon	Moderate: seepage, slope.	Severe: piping, wetness.	Severe: no water.	Percs slowly, frost action, slope.	Wetness, percs slowly, rooting depth.	Large stones, erodes easily.	Large stones, wetness.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
Hasbrouck	Severe: seepage.	Severe: piping, wetness.	Severe: no water.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, rooting depth.	Wetness, erodes easily, rooting depth.

See footnote at end of table.

Table 12.--Water Management--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
HctA: Hasbrouck	Severe: seepage.	Severe: piping, wetness.	Severe: no water.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, rooting depth.	Wetness, erodes easily, rooting depth.
NehBc: Neshaminy	Moderate: depth to rock, slope.	Severe: piping, hard to pack.	Severe: no water.	Deep to water	Slope	Large stones	Large stones.
NehCc, NehDc, NehFc: Neshaminy	Severe: slope.	Severe: piping, hard to pack.	Severe: no water.	Deep to water	Slope	Slope, large stones.	Large stones, slope.
NenB*, NenD*:							
Neshaminy	Severe: slope.	Severe: piping, hard to pack.	Severe: no water.	Deep to water	Slope	Slope, large stones.	Large stones, slope.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
Pbp: Parsippany	Moderate: seepage.	Severe: wetness.	Severe: slow refill, cutbanks cave.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Pbs*:							
Parsippany	Moderate: seepage.	Severe: wetness.	Severe: slow refill, cutbanks cave.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
Pcs: Passaic	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: slow refill, cutbanks cave.	Percs slowly, frost action, cutbanks cave.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, too sandy.	Wetness, erodes easily, percs slowly.
RarA: Raritan	Severe: seepage.	Severe: wetness, piping.	Severe: no water.	Frost action	Wetness, rooting depth.	Erodes easily, wetness.	Wetness, erodes easily.
RasA*:							
Raritan	Severe: seepage.	Severe: wetness, piping.	Severe: no water.	Frost action	Wetness, rooting depth.	Erodes easily, wetness.	Wetness, erodes easily.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
Passaic	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: slow refill, cutbanks cave.	Percs slowly, frost action, cutbanks cave.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, too sandy.	Wetness, erodes easily, percs slowly.

See footnote at end of table.

Table 12.--Water Management--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
SUCT*:							
Sulfihemists	Severe: seepage	Severe: seepage, piping, wetness	Variable	Variable	Variable	Variable	Variable.
Sulfaquents	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
TunE: Tunkhannock	Severe: seepage, slope.	Severe: seepage.	Severe: no water.	Deep to water	Large stones, droughty, slope.	Slope, large stones, too sandy.	Large stones, slope, droughty.
Ucd. Udifluvents	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
Udh, Udy, Udz. Udorthents	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
UR*. Urban land.	Variable	Variable	Variable	Variable	Variable	Variable	Variable.
WhpA: Whippany	Moderate: seepage.	Severe: wetness.	Severe: no water.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
WhpB: Whippany	Moderate: seepage, slope.	Severe: wetness.	Severe: no water.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
WhrB*:							
Whippany	Moderate: seepage, slope.	Severe: wetness.	Severe: no water.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Urban land	Variable	Variable	Variable	Variable	Variable	Variable	Variable.

* See description of the map unit for composition and behavior characteristics of the map unit.

Table 13.--Engineering Index Properties

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments 3-10 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
AmhB-------------	0-5	Silt loam--------	ML, CL,	A-4	0-5	85-95	75-90	65-85	50-75	20-30	3-10
Amwell			CL-ML								
	5-18	Clay loam, silt	CL, CL-ML	A-4, A-6	0-10	80-95	70-95	65-80	55-65	25-35	5-15
		loam, gravelly									
		silty clay loam.									
	18-60	Loam, silt loam	SC, CL,	A-4, A-6	0-10	65-95	50-95	40-80	35-60	25-40	5-15
		gravelly, silty	GM-GC, GC								
		clay loam.									
AmhCb------------	0-5	Silt loam,	ML, CL,	A-4	5-35	80-95	70-90	60-80	45-60	20-30	3-10
Amwell		very stony.	CL-ML								
	5-18	Clay loam, silt	CL, CL-ML	A-4, A-6	0-10	80-95	70-95	65-80	55-65	25-35	5-15
		loam, gravelly									
		silty clay loam.									
	18-60	Loam, silt loam,	ML, CL,	A-4, A-6	0-10	65-95	50-95	40-80	35-60	25-40	3-15
		silty clay loam.	GM, GC								
AmuB*:											
Amwell----------	0-5	Silt loam--------	ML, CL,	A-4	0-5	85-95	75-90	65-85	50-75	20-30	3-10
			CL-ML								
	5-18	Clay loam, silt	CL, CL-ML	A-4, A-6	0-10	80-95	70-95	65-80	55-65	25-35	5-15
		loam, gravelly									
		silty clay loam.									
	18-60	Loam, silt loam,	SC, CL,	A-4, A-6	0-10	65-95	50-95	40-80	35-60	25-40	5-15
		silty clay loam.	GM-GC, GC								
Urban land------	0-60	---	---	---	---	---	---	---	---	---	---
BhnB-------------	0-12	Silt loam--------	ML, CL-ML,	A-4	0	95-100	85-100	80-100	65-90	20-35	2-10
Birdsboro			CL								
	12-38	Silt loam,	ML, CL,	A-4, A-6	0-5	70-100	65-100	60-100	45-95	25-40	3-18
		gravelly sandy	SM, GM								
		clay loam,									
		gravelly loam.									
	38-60	Stratified sand	GM, SM,	A-2, A-4,	0-20	40-100	20-95	15-70	10-55	25-35	NP-7
		to very gravelly	ML, GP-GM	A-1							
		clay loam.									

See footnote at end of table.

Table 13.--Engineering Index Properties--Continued

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Fragments 3-10 inches	Percentage passing sieve number 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
BhpB*:											
Birdsboro-------	0-12	Silt loam--------	ML, CL-ML, CL	A-4	0	95-100	85-100	80-100	65-90	20-35	2-10
	12-38	Silt loam, sandy clay loam, gravelly clay loam.	ML, CL, SM, GM	A-4, A-6	0-5	70-100	65-100	60-100	45-95	25-40	3-18
	38-60	Stratified sand to very gravelly clay loam.	GM, SM, ML, GP-GM	A-2, A-4, A-1	0-20	40-100	20-95	15-70	10-55	25-35	NP-7
Urban land------	0-60	---	---	---	---	---	---	---	---	---	---
BogB------------- Boonton	0-8	Loam---------	CL-ML, SC-SM, ML, SM	A-4	0-5	80-95	75-90	55-85	35-75	<25	3-7
	8-36	Gravelly loam, gravelly fine sandy loam, silt loam.	CL-ML, SC-SM, CL, SC	A-2, A-4	0-10	85-100	50-95	40-90	25-75	20-30	4-10
	36-60	Gravelly sandy loam, loam, gravelly fine sandy loam.	SC, SC-SM, CL, CL-ML	A-2, A-4	0-10	80-95	50-95	35-85	25-60	20-30	4-10
BohC, BohD------- Boonton	0-3	Gravelly loam----	CL-ML, SC-SM, SM, ML	A-4, A-2	0-10	75-90	50-70	40-65	25-55	<25	3-7
	3-36	Gravelly loam, gravelly fine sandy loam, silt loam.	CL-ML, SC-SM, CL, SC	A-2, A-4	0-10	85-100	50-95	40-90	25-75	20-30	4-10
	36-60	Gravelly sandy loam, loam, gravelly fine sandy loam.	SC, SC-SM, CL, CL-ML	A-2, A-4	0-10	80-95	50-95	35-85	25-60	20-30	4-10
BovB*:											
Boonton---------	0-8	Loam-------------	CL-ML, SC-SM, ML, SM	A-4	0-5	80-95	75-90	55-85	35-75	<25	3-7
	8-36	Gravelly loam, gravelly fine sandy loam, silt loam.	CL-ML, SC-SM, CL, SC	A-2, A-4	0-10	85-100	50-95	40-90	25-75	20-30	4-10
	36-60	Gravelly sandy loam, loam, gravelly fine sandy loam.	SC, SC-SM, CL, CL-ML	A-2, A-4	0-10	80-95	50-95	35-85	25-60	20-30	4-10
Urban land------	0-60	---	---	---	---	---	---	---	---	---	---

See footnote at end of table.

Table 13.--Engineering Index Properties--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
BovB*:											
Haledon---------	0-9	Loam-------------	ML, CL, CL-ML	A-4	0-10	85-90	80-85	70-80	55-70	20-30	3-10
	9-28	Cobbly fine sandy loam, silt loam, gravelly loam.	CL-ML, SC-SM, ML	A-2, A-4	0-20	85-100	75-95	60-85	25-75	20-30	3-10
	28-44	Sandy loam, fine sandy loam, gravelly loam.	CL-ML, SC-SM, ML, SM	A-2, A-4	0-20	80-100	75-85	45-80	30-60	20-30	3-10
	44-60	Gravelly loam, sandy loam, loam.	SC-SM, CL-ML, SM	A-2, A-4	0-15	75-85	60-80	40-75	25-55	16-20	NP-8
BouD*:											
Boonton---------	0-3	Gravelly loam----	CL-ML, SC-SM, SM, ML	A-4, A-2	0-10	75-90	50-70	40-65	25-55	<25	3-7
	3-36	Gravelly loam, gravelly fine sandy loam, silt loam.	CL-ML, SC-SM, CL, SC	A-2, A-4	0-10	85-100	50-95	40-90	25-75	20-30	4-10
	36-60	Gravelly sandy loam, loam, gravelly fine sandy loam.	SC, SC-SM, CL, CL-ML	A-2, A-4	0-10	80-95	50-95	35-85	25-60	20-30	4-10
Urban land------	0-60	---	---	---	---	---	---	---	---	---	---
Cara*:											
Carlisle--------	0-60	Muck-------------	PT	A-8	0-30	---	---	---	---	---	---
Adrian----------	0-24	Muck-------------	PT	A-8	0-1	---	---	---	---	---	---
	24-60	Sand-------------	SP	A-3	0	100	95-100	75-90	1-4	---	NP
DunB------------- Dunellen	0-8	Sandy loam-------	SM, SC, ML, CL	A-2, A-4	0-2	95-100	75-100	60-80	30-70	20-30	3-10
	8-30	Sandy loam, loam, gravelly sandy loam.	SM, SC, ML, SC-SM	A-2, A-4, A-1	0-2	95-100	60-95	40-80	20-75	20-30	3-10
	30-60	Stratified very gravelly sand to loamy sand.	SM, SP-SM	A-2, A-1	0-10	70-80	40-65	30-55	10-25	<20	NP
DuuA*:											
Dunellen--------	0-8	Sandy loam-------	SM, ML, CL, CL-ML	A-2, A-4	0	95-100	75-100	60-80	30-70	20-30	3-10
	8-44	Sandy loam, loam, gravelly sandy loam.	SM, SC-SM, ML, CL-ML	A-2, A-4, A-1	0	95-100	60-95	40-80	20-65	20-30	3-10
	44-60	Stratified sandy loam to very gravelly sand.	SM, SP-SM	A-2, A-1	0-5	70-80	40-65	20-40	5-30	<20	NP
Urban land------	0-60	---	---	---	---	---	---	---	---	---	---

See footnote at end of table.

Table 13.--Engineering Index Properties--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
DuuB*, DuuD*:											
Dunellen	0-8	Sandy loam	SM, SC, ML, CL	A-2, A-4	0-2	95-100	75-100	60-80	30-70	20-30	3-10
	8-30	Sandy loam, loam, gravelly sandy loam.	SM, SC, ML, SC-SM	A-2, A-4, A-1	0-2	95-100	60-95	40-80	20-75	20-30	3-10
	30-60	Stratified very gravelly sand to loamy sand.	SM, SP-SM	A-2, A-1	0-10	70-80	40-65	30-55	10-25	<20	NP
Urban land	0-60		---	---	---	---	---	---	---	---	---
Fmt	0-60		---	---	---	---	---	---	---	---	---
Fluvaquents											
HakA, HakB	0-9	Loam	ML, CL, CL-ML	A-4	0-10	85-90	80-85	70-80	55-70	20-30	3-10
Haledon	9-28	Cobbly fine sandy loam, silt loam, gravelly loam.	CL-ML, SC-SM, ML	A-2, A-4	0-20	85-100	75-95	60-85	25-75	20-30	3-10
	28-44	Sandy loam, fine sandy loam, gravelly loam.	CL-ML, SC-SM, ML, SM	A-2, A-4	0-20	80-100	75-85	45-80	30-60	20-30	3-10
	44-60	Gravelly loam, sandy loam, loam.	SC-SM, CL-ML, SM	A-2, A-4	0-15	75-85	60-80	40-75	25-55	16-20	NP-8
HatB*:											
Haledon	0-9	Loam	ML, CL, CL-ML	A-4	0-10	85-90	80-85	70-80	55-70	20-30	3-10
	9-28	Cobbly fine sandy loam, silt loam, gravelly loam.	CL-ML, SC-SM, ML	A-2, A-4	0-20	85-100	75-95	60-85	25-75	20-30	3-10
	28-44	Sandy loam, fine sandy loam, gravelly loam. loam.	CL-ML, SC-SM, ML, SM	A-2, A-4	0-20	80-100	75-85	45-80	30-60	20-30	3-10
	44-60	Gravelly loam, sandy loam, loam.	SC-SM, CL-ML, SM	A-2, A-4	0-15	75-85	60-80	40-75	25-55	16-20	NP-8
Urban land	0-60	---	---	---	---	---	---	---	---	---	---
Hasbrouck	0-10	Silt loam	CL-ML, CL	A-4, A-6	0-5	90-100	75-90	60-85	50-80	20-30	5-15
	10-16	Sandy loam, loam	CL-ML, SC-SM, ML	A-2, A-4	0-5	90-100	75-90	45-80	20-60	16-25	3-10
	16-30	Loam, clay loam	CL-ML, CL	A-4, A-6	0-5	90-100	75-90	65-85	50-70	25-35	5-15
	30-52	Sandy loam, loam	ML, SM, SC-SM	A-4, A-2-4	0-5	75-95	70-90	55-80	30-60	20-30	3-10
	52-60	Loam, gravelly loam, sandy loam.	ML, SM, SC-SM	A-4, A-2-4, A-1-B	0-5	60-95	55-90	40-75	15-60	16-30	NP-10
HctA	0-10	Silt loam	CL-ML, CL	A-4, A-6	0-5	90-100	75-90	60-85	50-80	20-30	5-15
Hasbrouck	10-16	Sandy loam, loam	CL-ML, SC-SM, ML	A-2, A-4	0-5	90-100	75-90	45-80	20-60	16-25	3-10
	16-30	Loam, clay loam	CL-ML, CL	A-4, A 6	0 5	90-100	75-90	65-85	50-70	25-35	5 15
	30-52	Sandy loam, loam	ML, SM, SC-SM	A-4, A-2-4	0-5	75-95	70-90	55-80	30-60	20-30	3-10
	52-60	Loam, gravelly loam, sandy loam.	ML, SM, SC-SM	A-4, A 2-4, A-1-B	0-5	60-95	55-90	40-75	15-60	16-30	NP-10

See footnote at end of table.

Table 13.--Engineering Index Properties--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments 3-10 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
NehBc, NehCc, NehDc, NehFc: Neshaminy	0-14	Silt loam, extremely stony.	ML, CL	A-4, A 6	15-25	80-100	70-100	60-100	55-85	---	---
	14-60	Silt loam, cobbly clay loam, gravelly clay loam. clay loam.	ML, SM, MH, GM	A-4, A-7, A-2, A-6	0-40	60-100	55-100	45-100	30-75	25-55	NP-22
NenB*: Neshaminy	0-14	Extremely stony silt loam.	ML, CL	A-4, A-6	15-25	80-100	70-100	60-100	55-85	---	---
	14-60	Silt loam, gravelly silty clay loam, gravelly sandy clay loam.	ML, SM, MH, GM	A-4, A-7, A 2, A-6	0-40	60-100	55-100	45-100	30-75	25-55	NP-22
Urban land	0-60	---	---	---	---	---	---	---	---	---	---
NenD*: Neshaminy	0-14	Extremely stony silt loam.	ML, CL	A-4, A-6	15-25	80-100	70-100	60-100	55-85	---	---
	14-60	Silt loam, gravelly silty clay loam, gravelly sandy clay loam.	ML, SM, MH, GM	A-4, A-7, A-2, A-6	0-40	60-100	55-100	45-100	30-75	25-55	NP-22
Urban land	0-6	---	---	---	---	---	---	---	---	---	---
Pbp: Parsippany	0-8	Silt loam	CL, ML	A-6, A-7-6	0	95-100	95-100	90-100	75-85	30-45	8-15
	8-45	Silty clay loam, clay loam, silty clay.	CL	A-6, A-7	0	95-100	95-100	90-100	75-95	35-45	10-20
	45-60	Stratified loamy sand to silty clay.	SC, ML, SM, CL	A-7, A-4, A-2, A-6	0	95-100	70-100	45-95	15-90	25-45	3-20
Pbs*: Parsippany	0-8	Silt loam	CL, ML	A-6, A-7-6	0	95-100	95-100	90-100	75-85	30-45	8-15
	8-45	Silty clay loam, clay loam, silty clay.	CL	A-6, A-7	0	95-100	95-100	90-100	75-95	35-45	10-20
	45-60	Stratified loamy sand to silty clay.	SC, ML, SM, CL	A-7, A 4, A-2, A-6	0	95-100	70-100	45-95	15-90	25-45	3-20
Urban land	0-60	---	---	---	---	---	---	---	---	---	---
Pcs: Passaic	0-10	Silt loam	ML, CL, CL-ML	A-4, A-6	0	95-100	95-100	70-80	55-70	20-35	3-12
	10-28	Silty clay, silty clay loam, clay loam.	CH, MH, ML	A-6, A-7	0	95-100	90-100	85-100	75-95	35-55	12-15
	28-60	Stratified sandy loam to very gravelly sand.	SM, GM, SC-SM	A-3, A-1, A-4	0	45-100	40-100	20-70	5-40	16-25	NP-5

See footnote at end of table.

Table 13.--Engineering Index Properties--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments 3-10 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
RarA-------------- Raritan	0-12	Silt loam--------	ML, SM	A-4	0	85-100	75-90	60-90	45-80	---	---
	12-28	Clay loam, loam, silt loam.	ML, CL	A-4, A-6	0-5	90-100	80-95	70-90	50-70	25-35	3-11
	28-36	Clay loam, loam, silt loam.	ML, CL	A-4, A-6	0-5	90-100	80-95	70-90	50-70	25-35	3-11
	36-60	Stratified gravelly loamy sand to silty clay loam.	GM, GW-GM, SM, ML	A-1, A-2, A-4	0-10	60-100	40-90	20-90	10-85	25-35	NP-7
RasA*:											
Raritan---------	0-12	Silt loam--------	ML, SM	A-4	0	85-100	75-90	60-90	45-80	---	---
	12-28	Clay loam, loam, silt loam.	ML, CL	A-4, A-6	0-5	90-100	80-95	70-90	50-70	25-35	3-11
	28-36	Clay loam, loam, silt loam.	ML, CL	A-4, A-6	0-5	90-100	80-95	70-90	50-70	25-35	3-11
	36-60	Stratified gravelly loamy sand to silty clay loam.	GM, GW-GM, SM, ML	A-1, A-2, A-4	0-10	60-100	40-90	20-90	10-85	25-35	NP-7
Urban land------	0-60	---	---	---	---	---	---	---	---	---	---
Passaic---------	0-10	Silt loam--------	ML, CL, CL-ML	A-4, A-6	0	95-100	95-100	70-80	55-70	20-35	3-12
	10-28	Silty clay, silty clay loam, clay loam.	CH, MH, ML	A-6, A-7	0	95-100	90-100	85-100	75-95	35-55	12-15
	28-60	Stratified sandy loam to very gravelly sand.	SM, GM, SC-SM	A-3, A-1, A-4	0	45-100	40-100	20-70	5-40	16-25	NP-5
SUCT*: Sulfihemists.											
Sulfaquents.											
TunE------------- Tunkhannock	0-3	Gravelly loam----	SM, GM, SP, GP	A-1, A-2, A-4	0-20	50-90	30-70	25-60	10-45	---	---
	3-28	Very gravelly silt loam, very cobbly loam, very gravelly sandy loam.	SM, GM, SP-SM, GP-GM	A-2, A-1, A-4	0-35	40-80	25-75	20-60	10-45	<25	NP-3
	28-60	Very gravelly sandy loam, very cobbly loamy sand, very gravelly sand.	SM, GM, GP-GM, SP-SM	A-1, A-2, A-3	5-35	30-80	25-70	15-55	5-15	<20	NP-2
Ucd. Udifluvents	0-60	---	---	---	---	---	---	---	---	---	---

See footnote at end of table.

Table 13.--Engineering Index Properties--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
Udh.											
Udorthents	0-60	---	---	---	---	---	---	---	---	---	
Udy, Udz.											
Udorthents	0-60	---	---	---	---	---	---	---	---	---	
UR*---------------	0-60	---	---	---	---	---	---	---	---	---	---
Urban land.											
WhpA, WhpB-------	0-15	Silt loam---------	CL, CL-ML	A-4, A-6	0	95-100	85-100	75-100	50-80	25-35	5-15
Whippany	15-44	Clay, clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	95-100	90-100	75-95	35-55	15-30
	44-60	Stratified silty clay loam to loamy sand.	CL, CL-ML	A-4, A-6	0	85-100	80-100	65-100	50-85	20-35	5-15
WhrB*:											
Whippany---------	0-15	Silt loam---------	CL, CL-ML	A-4, A-6	0	95-100	85-100	75-100	50-80	25-35	5-15
	15-44	Clay, clay loam, silty clay.	CL, CH	A-6, A-7	0	95-100	95-100	90-100	75-95	35-55	15-30
	44-60	Stratified silty clay loam to loamy sand.	CL, CL-ML	A-4, A-6	0	85-100	80-100	65-100	50-85	20-35	5-15
Urban land-------	0-60	---	---	---	---	---	---	---	---	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

Table 14.--Physical and Chemical Properties of the Soils

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	In	Pct	G/cc	In/hr	In/in	pH				Pct
AmhB-------------	0-5	10-20	1.44-1.62	0.2-2.0	0.16-0.23	5.1-6.0	Low----------	0.43	4	2-4
Amwell	5-18	18-35	1.20-1.40	0.2-2.0	0.10-0.18	5.1-6.5	Moderate	0.37		---
	18-60	18-30	1.60-1.75	0.06-0.2	0.08-0.12	5.1-6.5	Low----------	0.32		---
AmhCb------------	0-5	10-20	1.44-1.62	0.2-2.0	0.12-0.16	5.1-6.0	Low----------	0.28	4	1-4
Amwell	5-18	18-35	1.48-1.66	0.2-2.0	0.10-0.18	5.1-6.5	Moderate-----	0.37		---
	18-60	18-30	1.60-1.75	0.06-0.2	0.08-0.12	5.1-6.5	Low----------	0.32		---
AmuB*:										
Amwell----------	0-5	10-20	1.44-1.62	0.2-2.0	0.16-0.23	5.1-6.0	Low----------	0.43	4	2-4
	5-18	18-35	1.20-1.40	0.2-2.0	0.10-0.18	5.1-6.5	Moderate-----	0.37		---
	18-60	18-30	1.60-1.75	0.06-0.2	0.08-0.12	5.1-6.5	Low----------	0.32		---
Urban land------	0-60	---	---	---	---	---	---	----	---	---
BhnB-------------	0-12	10-27	1.20-1.50	0.6-2.0	0.16-0.20	3.6-5.5	Low----------	0.37	4	1-3
Birdsboro	12-38	20-35	1.30-1.60	0.6-2.0	0.14-0.18	3.6-5.5	Low----------	0.28		---
	38-60	5-30	1.30-1.60	0.6-20	0.06-0.12	3.6-5.5	Low----------	0.17		---
BhpB*:										
Birdsboro-------	0-12	10-27	1.20-1.50	0.6-2.0	0.16-0.20	3.6-5.5	Low----------	0.37	4	1-3
	12-38	20-35	1.30-1.60	0.6-2.0	0.14-0.18	3.6-5.5	Low----------	0.28		---
	38-60	5-30	1.30-1.60	0.6-20	0.06-0.12	3.6-5.5	Low----------	0.17		---
Urban land------	0-60	---	---	---	---	---	---	----	---	---
BogB-------------	0-8	7-15	1.30-1.45	0.6-2.0	0.14-0.20	4.5-5.5	Low----------	0.43	3	2-4
Boonton	8-36	10-18	1.55-1.65	0.6-2.0	0.08-0.19	4.5-6.0	Low----------	0.37		---
	36-60	7-15	1.65-1.80	0.06-0.2	0.02-0.06	5.6-6.5	Low----------	0.28		---
BohC, BohD-------	0-3	7-15	1.30-1.45	0.6-2.0	0.11-0.16	4.5-5.5	Low----------	0.37	3	2-4
Boonton	3-36	10-18	1.55-1.65	0.6-2.0	0.08-0.19	4.5-6.0	Low----------	0.37		---
	36-60	7-15	1.65-1.80	0.06-0.2	0.02-0.06	5.6-6.5	Low----------	0.28		---
BovB*:										
Boonton---------	0-8	7-15	1.30-1.45	0.6-2.0	0.14-0.20	4.5-5.5	Low----------	0.43	3	2-4
	8-36	10-18	1.55-1.65	0.6-2.0	0.08-0.19	4.5-6.0	Low----------	0.37		---
	36-60	7-15	1.65-1.80	0.06-0.2	0.02-0.06	5.6-6.5	Low----------	0.28		---
Urban land------	0-60	---	---	---	---	---	---	----	---	---
Haledon---------	0-9	10-25	1.20-1.40	0.6-2.0	0.18-0.22	4.5-6.0	Low----------	0.32	3	2-4
	9-28	10-20	1.30-1.50	0.6-2.0	0.14-0.19	5.1-6.5	Low----------	0.43		---
	28-44	10-20	1.60-1.80	0.06-0.6	0.06-0.10	5.6-7.3	Low----------	0.24		---
	44-60	10-20	1.30-1.50	0.06-0.6	0.06-0.10	5.6-7.3	Low----------	0.20		---

See footnote at end of table.

Table 14.--Physical and Chemical Properties of the Soils--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	In	Pct	G/cc	In/hr	In/in	pH				Pct
BouD*:										
Boonton	0-3	7-15	1.30-1.45	0.6-2.0	0.11-0.16	4.5-5.5	Low	0.37	3	2-4
	3-36	10-18	1.55-1.65	0.6-2.0	0.08-0.19	4.5-6.0	Low	0.37		---
	36-60	7-15	1.65-1.80	0.06-0.2	0.02-0.06	5.6-6.5	Low	0.28		---
Urban land	0-60	---	---	---	---	---	---	----	---	---
Cara*:										
Carlisle	0-60	---	0.13-0.23	0.2-6.0	0.35-0.45	4.5-7.8	---	----	5	>70
Adrian	0-24	---	0.30-0.55	0.2-6.0	0.35-0.45	5.6-7.3	---	----	4	55-75
	24-60	1-4	1.40-1.75	6.0-20	0.05-0.07	6.1-7.3	Low	0.15		
DunB Dunellen	0-8	5-20	1.10-1.30	2.0-6.0	0.13-0.16	4.5-5.5	Low	0.24	3	2-4
	8-30	5-18	1.20-1.40	0.6-6.0	0.10-0.20	4.5-5.5	Low	0.32	---	---
	30-60	5-15	1.30-1.50	>6.0	0.05 0.10	5.1-6.0	Low	0.24	---	---
DuuA*:										
Dunellen	0-8	5-20	1.10 1.30	2.0-6.0	0.13-0.16	4.5-5.5	Low	0.24	4	2-4
	8-44	5-18	1.20-1.40	0.6-6.0	0.10-0.20	4.5-5.5	Low	0.32	---	---
	44-60	5-15	1.30-1.50	2.0-6.0	0.05-0.10	5.1-6.0	Low	0.24	---	---
Urban land	0-60	---	---	---	---	---	---	----	---	---
DuuB*, DuuD*:										
Dunellen	0-8	5-20	1.10-1.30	2.0-6.0	0.13-0.16	4.5-5.5	Low	0.24	3	2-4
	8-30	5-18	1.20-1.40	0.6-6.0	0.10-0.20	4.5-5.5	Low	0.32	---	---
	30 60	5-15	1.30-1.50	>6.0	0.05-0.10	5.1-6.0	Low	0.24	---	---
Urban land	0-60	---	---	---	---	---	------------	----	---	---
Fmt Fluvaquents	0 8	10-17	1.20-1.40	0.6-2.0	0.16-0.20	5.1-6.5	Low	0.32	4	1-2
	8-31	15-30	1.30-1.50	0.2-0.6	0.16-0.20	5.1-6.5	Low	0.28		---
	31-50	15-30	1.20-1.50	0.2-2.0	0.12-0.18	5.1-7.3	Low	0.28		---
	50-60	0-10	1.20-1.70	2.0-6.0	0.04-0.08	5.1-7.3	Low	0.17		---
HakA, HakB Haledon	0-9	10-25	1.20-1.40	0.6-2.0	0.18-0.22	4.5-6.0	Low	0.32	3	2-4
	9-28	10-20	1.30-1.50	0.6-2.0	0.14-0.19	5.1-6.5	Low	0.43	---	---
	28-44	10-20	1.60-1.80	0.06-0.6	0.06-0.10	5.6-7.3	Low	0.24	---	---
	44-60	10-20	1.30-1.50	0.06-0.6	0.06-0.10	5.6-7.3	Low	0.20		
HatB*:										
Haledon	0-9	10-25	1.20-1.40	0.6-2.0	0.18-0.22	4.5-6.0	Low	0.32	3	2-4
	9-28	10-20	1.30-1.50	0.6-2.0	0.14-0.19	5.1-6.5	Low	0.43	---	---
	28-44	10-20	1.60-1.80	0.06-0.6	0.06-0.10	5.6-7.3	Low	0.24	---	---
	44-60	10-20	1.30-1.50	0.06-0.6	0.06-0.10	5.6-7.3	Low	0.20	---	---
Urban land	0-60	---	---	---	---	---	---	----	---	---
Hasbrouck	0-10	15-25	1.40-1.60	0.6-2.0	0.15-0.22	4.5-6.5	Low	0.37	4	3-5
	10-16	5-15	1.40-1.60	0.6-2.0	0.10-0.18	4.5-6.5	Low	0.24	---	---
	16-30	20-30	1.50-1.65	0.6-2.0	0.15-0.22	4.5-6.5	Low	0.37	---	---
	30-52	10-20	1.65-1.85	<0.2	0.06-0.10	5.6-6.5	Low	0.24	---	---
	52-60	3-20	1.50-1.65	0.6-6.0	0.05-0.15	6.1-7.3	Low	0.24	---	---
HctA Hasbrouck	0-10	15-25	1.40-1.60	0.6-2.0	0.15-0.22	4.5-6.5	Low	0.37	4	3-5
	10-16	5-15	1.40-1.60	0.6-2.0	0.10-0.18	4.5-6.5	Low	0.24	---	---
	16-30	20-30	1.50-1.65	0.6-2.0	0.15-0.22	4.5-6.5	Low	0.37	---	---
	30-52	10-20	1.65-1.85	<0.2	0.06-0.10	5.6-6.5	Low	0.24	---	---
	52-60	3-20	1.50-1.65	0.6-6.0	0.05-0.15	6.1-7.3	Low	0.24	---	---

See footnote at end of table.

Table 14.--Physical and Chemical Properties of the Soils--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	In	Pct	G/cc	In/hr	In/in	pH				Pct
NehBc, NehCc, NehDc, NehFc---- Neshaminy	0-14	10-25	1.20-1.40	0.6-2.0	0.12-0.20	4.5-6.0	Low----------	0.24	4	---
	14-60	20-40	1.40-1.60	0.2-0.6	0.10-0.14	5.1-6.5	Low----------	0.17	---	---
NenB*:										
Neshaminy-------	0-14	10-25	1.20-1.40	0.6-2.0	0.12-0.20	4.5-6.0	Low----------	0.24	4	---
	14-60	20-40	1.40-1.60	0.2-0.6	0.10-0.14	5.1-6.5	Low----------	0.17	---	---
Urban land------	0-60	---	---	---	---	---	---	---	---	---
NenD*:										
Neshaminy-------	0-14	10-25	1.20-1.40	0.6-2.0	0.12-0.20	4.5-6.0	Low----------	0.24	4	---
	14-60	20-40	1.40-1.60	0.2-0.6	0.10-0.14	5.1-6.5	Low----------	0.17	---	---
Urban land------	0-6	---	---	---	---	---	---	---	---	---
Ppp-------------- Parsippany	0-8	20-30	1.28-1.44	0.6-2.0	0.18-0.22	5.1-6.0	Low----------	0.43	4	1-3
	8-45	35-45	1.35-1.55	0.06-0.2	0.14-0.18	5.1-6.5	Moderate-----	0.43	---	---
	45-60	5-45	1.30-1.55	0.2-6.0	0.14-0.18	6.1-7.3	Moderate-----	0.43	---	---
Pbs*:										
Parsippany------	0-8	20-30	1.28-1.44	0.6-2.0	0.18-0.22	5.1-6.0	Low----------	0.43	4	1-3
	8-45	35-45	1.35-1.55	0.06-0.2	0.14-0.18	5.1-6.5	Moderate-----	0.43	---	---
	45-60	5-45	1.30-1.55	0.2-6.0	0.14-0.18	6.1-7.3	Moderate-----	0.43	---	---
Urban land------	0-60	---	---	---	---	---	---	---	---	---
Pcs-------------- Passaic	0-10	15-25	1.20-1.45	0.6-2.0	0.18-0.22	4.5-6.0	Low----------	0.43	2	.5-4
	10-28	35-45	1.25-1.50	0.06-0.2	0.14-0.18	5.1-7.3	Moderate-----	0.43	---	---
	28-60	5-15	1.30-1.60	0.6-20.0	0.12-0.14	6.6-7.8	Low----------	0.20	---	---
RarA------------- Raritan	0-12	10-20	1.20-1.40	0.6-2.0	0.16-0.20	4.5-6.0	Low----------	0.37	3-2	2-4
	12-28	18-34	1.40-1.60	0.6-2.0	0.12-0.16	4.5-6.0	Low----------	0.28	---	---
	28-36	18-34	1.40-1.60	0.2-0.6	0.08-0.12	4.5-6.0	Low----------	0.28	---	---
	36-60	5-15	1.40-1.60	0.6-6.0	0.06-0.10	4.5-6.0	Low----------	0.28	---	---
RasA*:										
Raritan---------	0-12	10-20	1.20-1.40	0.6-2.0	0.16-0.20	4.5-6.0	Low----------	0.37	3-2	2-4
	12-28	18-34	1.40-1.60	0.6-2.0	0.12-0.16	4.5-6.0	Low----------	0.28	---	---
	28-36	18-34	1.40-1.60	0.2-0.6	0.08-0.12	4.5-6.0	Low----------	0.28	---	---
	36-60	5-15	1.40-1.60	0.6-6.0	0.06-0.10	4.5-6.0	Low----------	0.28	---	---
Urban land------	0-60	---	---	---	---	---	---	---	---	---
Passaic---------	0-10	15-25	1.20-1.45	0.6-2.0	0.18-0.22	4.5-6.0	Low----------	0.43	2	.5-4
	10-28	35-45	1.25-1.50	0.06-0.2	0.14-0.18	5.1-7.3	Moderate-----	0.43	---	---
	28-60	5-15	1.30-1.60	0.6-20.0	0.12-0.14	6.6-7.8	Low----------	0.20	---	---
SUCT*:										
Sulfihemists.	0-60									
Sulfaquents.	0-60									

See footnote at end of table.

Table 14.--Physical and Chemical Properties of the Soils--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Organic matter
	In	Pct	G/cc	In/hr	In/in	pH				Pct
TunE-------------- Tunkhannock	0-3	10-20	1.20-1.40	2.0-6.0	0.08-0.15	3.6-6.0	Low-----------	0.24	3	2-4
	3-28	10-20	1.40-1.60	2.0-6.0	0.08-0.12	3.6-6.0	Low-----------	0.17	---	---
	28-60	10-20	1.40-1.60	2.0-20	0.01-0.08	3.6-6.0	Low-----------	0.17	---	---
Ucd. Udifluvents	0-60	---	---	---	---	---	---	---	---	---
Udh. Udorthents	0-60	---	---	---	---	---	---	---	---	---
Udy, Udz. Udorthents	0-60	---	---	---	---	---	---	---	---	---
UR*--------------- Urban land.	0-60	---	---	---	---	---	---	----	---	---
WhpA, WhpB-------- Whippany	0-15	15-27	1.25-1.50	0.6-2.0	0.18-0.22	5.1-6.0	Low-----------	0.43	3	1-5
	15-44	35-50	1.35-1.55	0.06-0.2	0.14-0.18	5.1-6.0	Moderate------	0.37	---	---
	44-60	15-35	1.30-1.45	0.2-2.0	0.18-0.22	6.1-7.3	Moderate------	0.32	---	---
WhrB*:										
Whippany---------	0-15	15-27	1.25-1.50	0.6-2.0	0.18-0.22	5.1-6.0	Low-----------	0.43	3	1-5
	15-44	35-50	1.35-1.55	0.06-0.2	0.14-0.18	5.1-6.0	Moderate------	0.37		
	44-60	15-35	1.30-1.45	0.2-2.0	0.18-0.22	6.1-7.3	Moderate------	0.32		
Urban land-------	0-60	---	---	---	---	---	---	----	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

Table 15.--Soil and Water Features

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Total subsidence	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In		In			
AmhB, AmnCb----- Amwell	C	None--------	---	---	1.0-4.0	Perched	Oct-Jun	>60	---	---	High-----	High-----	Moderate.
AmuB*:													
Amwell---------	C	None--------	---	---	1.0-4.0	Perched	Oct-Jun	>60	---	---	High-----	High-----	Moderate.
Urban land-----	-	None--------	---	---	>2.0	---	---	>10	---	---	---	---	---
BhnB------------ Birdsboro	B	Rare--------	---	---	2.0-6.0	Apparent	Nov-Mar	>60	---	---	Moderate	Moderate	High.
BhpB*:													
Birdsboro------	B	Rare--------	---	---	2.0 6.0	Apparent	Nov-Mar	>60	---	---	Moderate	Moderate	High.
Urban land-----	-	None--------	---	---	>2.0	---	---	>10	---	---	---	---	---
BogB, BohC, BohD Boonton	C	None--------	---	---	1.5 3.0	Perched	Nov-May	>60	---	---	Moderate	Moderate	High.
BovB*:													
Boonton--------	C	None--------	---	---	1.5-3.0	Perched	Nov-May	>60	---	---	Moderate	Moderate	High.
Urban land-----	-	None--------	---	---	>2.0	---	---	>10	---	---	---	---	---
Haledon--------	C	None--------	---	---	0.5-1.5	Perched	Dec-May	>60	---	---	High-----	Moderate	Moderate.
BouD*:													
Boonton--------	C	None--------	---	---	1.5-3.0	Perched	Nov-May	>60	---	---	Moderate	Moderate	High.
Urban land-----	-	None--------	---	---	>2.0	---	---	>10	---	---	---	---	---
Cara*:													
Carlisle-------	A/D	Frequent----	Very brief to long.	Nov-Apr	+.5-1.0	Apparent	Sep-Jun	>60	---	43-54	High-----	High-----	Low.
Adrian---------	A/D	Frequent----	Long------	Oct-Jun	+3-0.5	Apparent	Oct-Jun	>60	---	29-33	High-----	High-----	Moderate.
DunB---------- Dunellen	B	None--------	---	---	>6.0	---	---	>60	---	---	Moderate	Low------	Moderate.

See footnote at end of table.

Table 15.--Soil and Water Features--Continued

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Total subsidence	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In		In			
DuuA*:													
Dunellen-------	B	None---------	---	---	4.0-6.0	Apparent	Dec-May	>60	---	---	Moderate	Low------	Moderate.
Urban land-----	-	None---------	---	---	>2.0	---	---	>10	---	---	---	---	---
DuuB*, DuuD*:													
Dunellen-------	B	None---------	---	---	>6.0	---	---	>60	---	---	Moderate	Low------	Moderate.
Urban land-----	-	None---------	---	---	>2.0	---	---	>10	---	---	---	---	---
Fmt------------- Fluvaquents	B/D	Frequent----	Brief-----	Nov-Jun	0-1.5	Apparent	Sep-May	>60	---	---	High-----	High-----	Moderate.
HakA, HakB------ Haledon	C	None---------	---	---	0.5-1.5	Perched	Dec-May	>60	---	---	High-----	Moderate	Moderate.
HatB*:													
Haledon--------	C	None---------	---	---	0.5-1.5	Perched	Dec-May	>60	---	---	High-----	Moderate	Moderate.
Urban land-----	-	None---------	---	---	>2.0	---	---	>10	---	---	---	---	---
Hasbrouck------	D	Rare---------	---	---	0-0.5	Perched	Nov-Jun	>60	---	---	High-----	High-----	Moderate.
HctA------------ Hasbrouck	D	Rare---------	---	---	0-0.5	Perched	Nov-Jun	>60	---	---	High-----	High-----	Moderate.
NehBc, NehCc, NehDc, NehFc--- Neshaminy	B	None---------	---	---	>6.0	---	---	>48	Hard	---	Moderate	Moderate	Moderate.
NenB*, NenD*:													
Neshaminy------	B	None---------	---	---	>6.0	---	---	>48	Hard	---	Moderate	Moderate	Moderate.
Urban land-----	-	None---------	---		>2.0	---	---	>10	---	---	---	---	---
Pbp------------- Parsippany	C/D	Occasional	Brief-----	Dec-May	0-1.0	Apparent	Oct-May	>60	---	---	High-----	High-----	Moderate.
Pbs*:													
Parsippany-----	C/D	Occasional	Brief-----	Dec-May	0-1.0	Apparent	Oct-May	>60	---	---	High-----	High-----	Moderate.
Urban land-----	-	None---------	---	---	>2.0	---	---	>10	---	---	---	---	---
Pcs------------- Passaic	D	Frequent----	Brief-----	Feb-May	0-1.0	Apparent	Oct-May	>60	---	---	High-----	High-----	High.
RarA------------ Raritan	C	Rare--------	---	---	0.5-3.0	Perched	Nov-Mar	>60	---	---	High-----	High-----	Moderate.
RasA*:													
Raritan--------	C	Rare------	---	---	0.5-3.0	Perched	Nov-Mar	>60	---	---	High-----	High-----	Moderate.
Urban land-----	-	None--------	---	---	>2.0	---	---	>10	---	---	---	---	---
Passaic--------	D	Frequent----	Brief-----	Feb-May	0-1.0	Apparent	Oct-May	>60	---	---	High-----	High-----	High.

See footnote at end of table.

Table 15.--Soil and Water Features--Continued

Soil name and map symbol	Hydrologic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Total subsidence	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In		In			
SUCT*:													
Sulfihemists.	D	Frequent---	Brief to long.	Daily	0-1.0	Apparent	Jan-Dec	>60	---	---	---	---	---
Sulfaquents.	D	Frequent---	Brief to long.	Daily	0-1.0	Apparent	Jan-Dec	>60	---	---	---	---	---
TunE----------- Tunkhannock	A	None---------	---	---	>6.0	---	---	>60	---	---	Low------	Low------	High.
Ucd. Udifluvents	C	Frequent----	Brief to long.	Jan-Dec	0.5-4.0	Apparent	Jan-Dec	>60	---	---	---	---	---
Udh, Udy, Udz. Udorthents.	-	---	---	---	---	---	---	---	---	---	---	---	---
UR*------------- Urban land.	-	None---------	---	---	>2.0	---	---	>10	---	---	---	---	---
WhpA, WhpB---- Whippany	C	Rare---------	---	---	0.5-1.5	Perched	Oct-May	>60	---	---	High-----	High-----	Moderate.
WhrB*:													
Whippany--------	C	Rare-------	---	---	0.5-1.5	Perched	Oct-May	>60	---	---	High-----	High-----	Moderate.
Urban land----	-	None---------	---	---	>2.0	---	---	>10	---	---	---	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

Table 16.--Classification of the Soils

Soil name	Family or higher taxonomic class
Adrian	Sandy or sandy-skeletal, mixed, euic, mesic Terric Medisaprists
Amwell	Fine-loamy, mixed, mesic Aquic Fragiudalfs
Birdsboro	Fine-loamy, mixed, mesic Typic Hapludults
Boonton	Coarse-loamy, mixed, mesic Typic Fragiudalfs
Carlisle	Euic, mesic Typic Medisaprists
Dunellen	Coarse-loamy, mixed, mesic Typic Hapludults
Fluvaquents	Fluvaquents
Haledon	Coarse-loamy, mixed, mesic Aquic Fragiudalfs
Hasbrouck	Fine-loamy, mixed, mesic Typic Fragiaqualfs
Neshaminy	Fine-loamy, mixed, mesic Ultic Hapludalfs
Parsippany	Fine, mixed, mesic Aeric Ochraqualfs
Passaic	Clayey over sandy or sandy-skeletal, mixed, mesic Aeric Ochraqualfs
Raritan	Fine-loamy, mixed, mesic Aquic Fragiudults
Sulfaquents	Sulfaquents
Sulfihemists	Sulfihemists
Tunkhannock	Loamy-skeletal, mixed, mesic Typic Dystrochrepts
Udifluvents	Udifluvents
Udorthents	Udorthents
Whippany	Fine, mixed, mesic Aquic Hapludalfs

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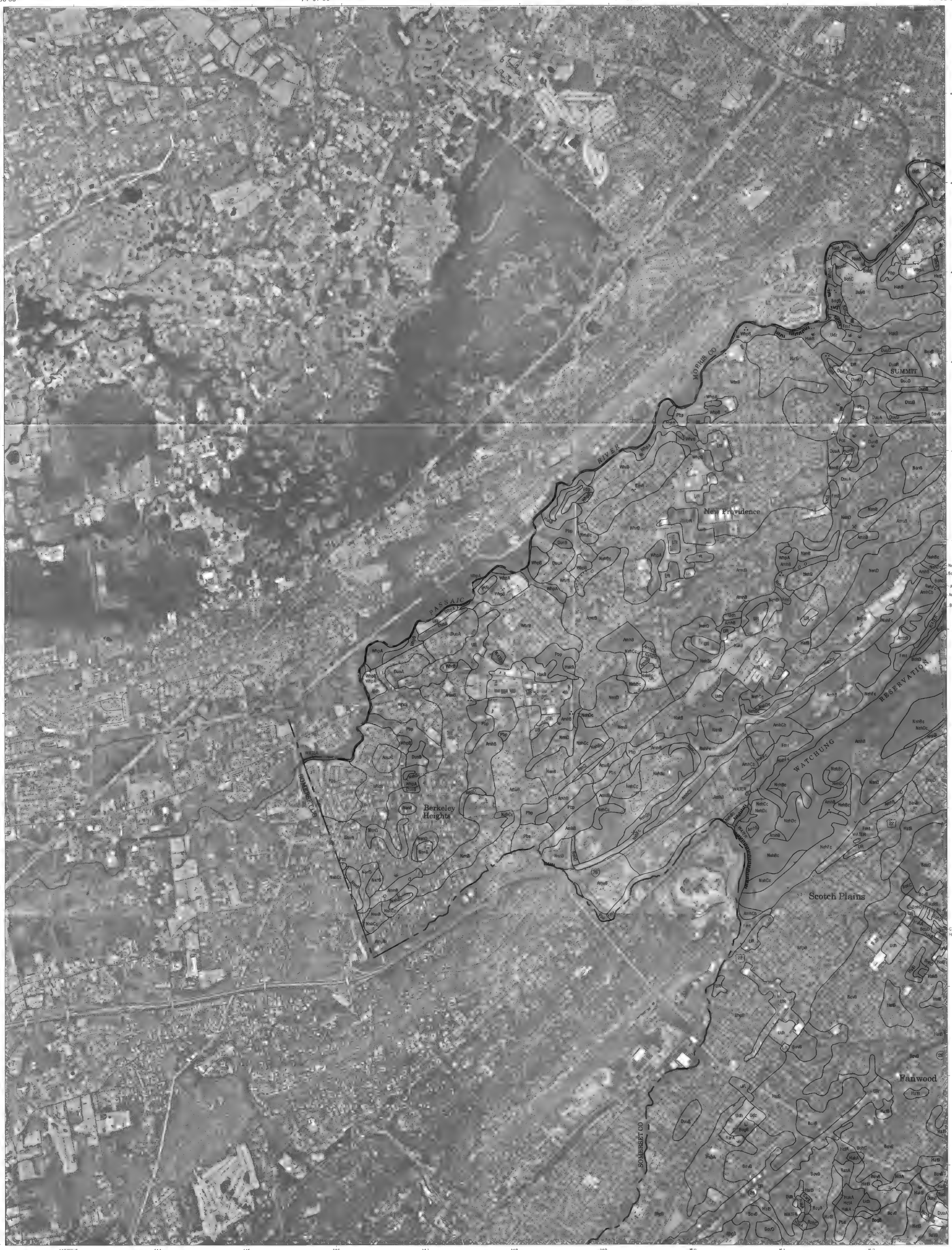
UNITED STATES
DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

UNION COUNTY, NEW JERSEY
CHATHAM QUADRANGLE
SHEET NUMBER 1



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North American Datum of 1983 (NAD83). GRS-80 Spheroid 1000-meter ticks: Universal Transverse Mercator, zone 18. Coordinate grid ticks and land division data, if shown, are approximately positioned. Digital data are available for this quadrangle.

QUADRANGLE LOCATION

SCALE 1:24000

KILOMETERS

FEET

MILES

1	2	3
4		5
6	7	8

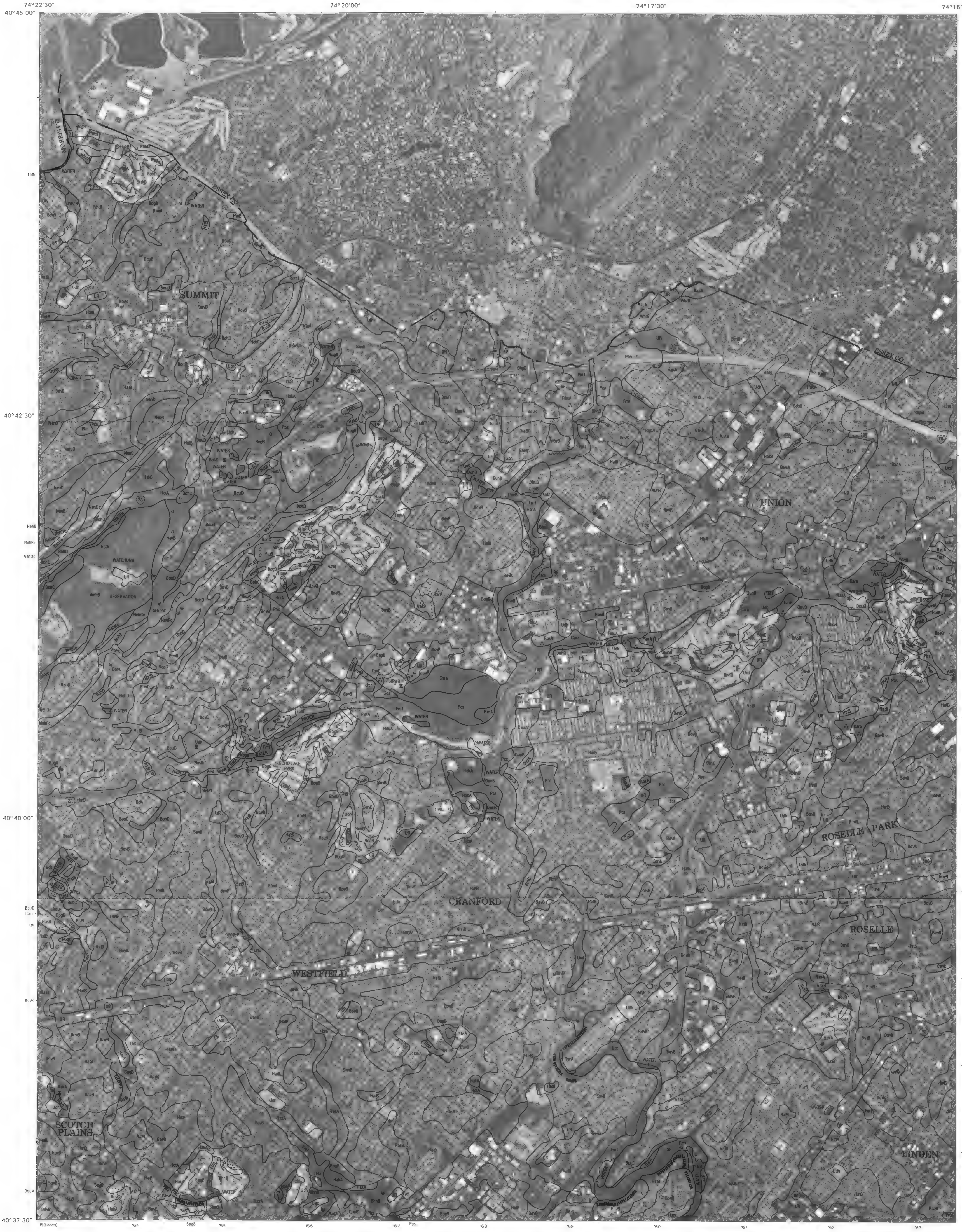
1 MENDHAM
2 MORRISTOWN
3 CALDWELL
4 BERNARDSVILLE
5 ROSELLE
6 BOUND BROOK
7 PLAINFIELD
8 PERTH AMBOY

INDEX TO ADJOINING 7.5 MAPS

CHATHAM, NEW JERSEY
7.5 MINUTE SERIES
SHEET NUMBER 1

UNITED STATES
DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

UNION COUNTY, NEW JERSEY
ROSELLE QUADRANGLE
SHEET NUMBER 2



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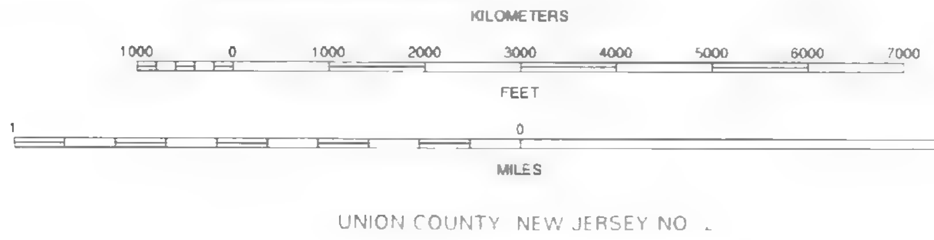
NORTH

QUADRANGLE LOCATION

SCALE 1:24000



1	2	3
4		5
6	7	8

1 MORRISTOWN
2 CALDWELL
3 ORANGE
4 CHATHAM
5 ELIZABETH
6 PLAINFIELD
7 PERTH AMBOY
8 ARTHUR KILL

INDEX TO ADJOINING 7.5 MAPS

ROSELLE, NEW JERSEY
7.5 MINUTE SERIES
SHEET NUMBER 2

UNITED STATES
DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

UNION COUNTY, NEW JERSEY
ELIZABETH QUADRANGLE
SHEET NUMBER 3

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NORTH

QUADRANGLE LOCATION

SCALE 1:24000

1 0 1 KILOMETERS

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 0 1 MILES

1	2	3
4		5
6	7	8

1 CALDWELL
2 ORANGE
3 WEEHAWKEN
4 ROSELLE
5 JERSEY CITY
6 PERTH AMBOY
7 ARTHUR KILL
8 THE NARROWS

INDEX TO ADJOINING 7.5 MAPS

ELIZABETH, NEW JERSEY
7.5 MINUTE SERIES
SHEET NUMBER 3

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UNION COUNTY, NEW JERSEY
PLAINFIELD QUADRANGLE
SHEET NUMBER 4

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North American Datum of 1983 (NAD83). GRS-80 Spheroid
1000-meter ticks: Universal Transverse Mercator, zone 18.
Coordinate grid ticks and land division data, if shown, are approximately positioned. Digital data are available for this quadrangle.

NORTH

QUADRANGLE LOCATION

SCALE 1:24000

KILOMETERS

FEET

MILES

1	2	3
4		5
6	7	8

1 BERNARDSVILLE
2 CHATHAM
3 ROSELLE
4 BOUND BROOK
5 PERTH AMBOY
6 MONMOUTH JUNCTION
7 NEW BRUNSWICK
8 SOUTH AMBOY

INDEX TO ADJOINING 7.5 MAPS

PLAINFIELD, NEW JERSEY
7.5 MINUTE SERIES
SHEET NUMBER 4

UNITED STATES
DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

UNION COUNTY, NEW JERSEY
PERTH AMBOY QUADRANGLE
SHEET NUMBER 5

This soil survey was compiled by the U.S. Department of Agriculture, Natural Resources Conservation Service, formerly Soil Conservation Service, and cooperating agencies. Soil lines were compiled on orthophotographs prepared by the U.S. Department of Interior, Geological Survey, from 1986 aerial photography. The photo background for this map is an orthophotograph prepared by the U.S. Department of the Interior, Geological Survey, from 1995 aerial photography.

North American Datum of 1983 (NAD83). GRS-80 Spheroid 1000-meter ticks: Universal Transverse Mercator, zone 18. Coordinate grid ticks and land division data, if shown, are approximately positioned. Digital data are available for this quadrangle.

NORTH

QUADRANGLE LOCATION

SCALE 1:24000

KILOMETERS

FEET

MILES

1	2	3
4		5
6	7	8

1 CHATHAM
2 ROSELLE
3 ELIZABETH
4 PLAINFIELD
5 ARTHUR KILL
6 NEW BRUNSWICK
7 SOUTH AMBOY
8 KEYPORT

INDEX TO ADJOINING 7.5 MAPS

PERTH AMBOY, NEW JERSEY
7.5 MINUTE SERIES
SHEET NUMBER 5

UNITED STATES
DEPARTMENT OF AGRICULTURE
NATURAL RESOURCES CONSERVATION SERVICE

UNION COUNTY, NEW JERSEY
ARTHUR KILL QUADRANGLE
SHEET NUMBER 6

This soil survey was compiled by the U.S. Department of Agriculture, Natural Resources Conservation Service, formerly Soil Conservation Service, and cooperating agencies. Soil lines were compiled on orthophotographs prepared by the U.S. Department of Interior, Geological Survey, from 1986 aerial photography. The photo background for this map is an orthophotograph prepared by the U.S. Department of the Interior, Geological Survey, from 1995 aerial photography.

North American Datum of 1983 (NAD83). GRS-80 Spheroid 1000-meter ticks: Universal Transverse Mercator, zone 18. Coordinate grid ticks and land division data, if shown, are approximately positioned. Digital data are available for this quadrangle.

NORTH

QUADRANGLE LOCATION

SCALE 1:24000

1 0 1
KILOMETERS

1000 0 1000 2000 3000 4000 5000 6000 7000
FEET

1 0
MILES

1	2	3
4		5
6	7	8

1 ROSELLE
2 ELIZABETH
3 JERSEY CITY
4 PERTH AMBOY
5 THE NARROWS
6 SOUTH AMBOY
7 KEYPORT
8 SANDY HOOK

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ARTHUR KILL, NEW JERSEY
7.5 MINUTE SERIES
SHEET NUMBER 6